# Sex, disgust, and penetration disorders

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# Sex, disgust, and penetration disorders

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To all women that are sexually misused

# Overview

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# Chapter 1

# Introduction

> Nature has placed mankind under the governance of two sovereign masters, pain and pleasure.
>
> Jeremy Bentham 1789

Sexuality to date is one of the foremost among women's health issues as can be judged from the media coverage, the taboo that surrounds it and an increasing number of scientific attempts to understand what is expected or considered as sexual dysfunctional. I start this thesis by introducing two distinct areas of interest, female sexual pain disorders and the emotion of disgust, along with how these two are possibly intertwined. The excerpt on the next page (see Section 1.1) illustrates how painful intercourse or the complete inability to have sexual intercourse, may have a serious negative impact on quality of life, relationships and overall emotional well being. This part of the thesis will start off with a description of the main female sexual pain disorders, including a clinical picture and an outline of the current diagnostic boundaries. Subsequently, focus is then placed on existing theories that might have an aetiological or maintaining influence (e.g., pain catastrophizing cognitions, conservative values, dysfunctional sexual beliefs and negative emotionality towards sexual stimulation).

Next, I tap into the negative emotions underpinning sexual pain disorders with particular focus on the emotion of disgust. After being labeled as the 'forgotten emotion of psychiatry' just over a decade ago (Phillips et al., 1998), disgust has increasingly been given the spot light to an extent that recently it has been referred to as the 'belle of the ball' (Tybur, 2009). However, as a potentially relevant factor in human sexuality, there is somehow a negligence of empirically supported research about its possible relevance. Here I will provide an overview of the literature on disgust, after which I will focus on sub-categories of disgust elicitors (i.e., core-, socio-moral-, animal-reminders-disgust etc.) and individual disgust traits (i.e., disgust propensity, disgust sensitivity). This section is aimed at defining the conceptualiza-

tion of disgust and its link to sexual pain. Furthermore, throughout the first chapter I will outline remaining research questions that led to the designs of the studies that are covered in this thesis and finally, I will conclude with an outline of this work presented here.

## 1.1 Sexual pain disorders

> *'...I had a partner who tried to insert a finger during foreplay and was unable. I also was unable to ever insert anything myself. I thought I would never be able to have children because of it ... this seriously affected me ... it was embarrassing to not be able to experience every part of sex. I had to tell when I dated that I did not like insertion so they did not try it unexpectedly on me... I figured I would never be able to use my vagina as normal women did. I had low self-esteem when it cames to vaginismus because I felt I was not normal... I avoided sex... because I was afraid my partner would by accident put his hand too near my vagina which would cause me to tense up. ...It's like my body always goes into protective mode and I have to make sure I don't get hurt,... it is just this feeling... and its so strong that it takes over my mind and my body reacts to it.'*

(An excerpt describing how this patient's experience vaginismus, collected by Ms Alisa Frick as partial fulfillment of her internship)

> *'...Disgust is a very strong feeling that takes over any other feeling or emotion. It brings about the feeling of dirt (personally) stretching from any crawling insects to people. For some... the two (disgust and sex) are viewed as one. In my personal experience I describe the sex as simply disgusting. Have you ever felt a crawling insect crawling on your hands while you are sleeping on a low mattress on a breezy summer night while camping? Insects crawl in a very slow pace but they are there and when you realize they are on your body, Mr. Insect would have already toured an extensive part of your body: ... the penis stabbing my vagina was the worst. It felt like insects were let loose and they were crawling out of my vagina for hours and hours. It was horrible, the smell, the touch, the feeling, everything. How can a woman ever describe sex as pleasure? I don't understand.'*

(An excerpt from a woman's description of how she perceives emotions in relation to sexual intercourse)

### 1.1.1 Clinical descriptions and definitions

In the DSM-IV-TR version, under the umbrella of female sexual pain disorders lays vaginismus and dyspareunia (DSM-IV-TR, 2000). In this version of the DSM, vaginismus is described as:

> *'otherwise unexplained recurrent or persistent involuntary contraction of the perineal muscles around the outer third of the vagina associated with penetration causing distress and interpersonal difficulties'.*

However, it is more frequently conceptualized as:

> *'persistent difficulties to allow vaginal entry of a penis, finger and object, despite the woman's wish to do so. There is variable involuntary muscle contraction, (phobic) avoidance and anticipation/fear/experience of pain. Structural or other physical abnormalities must be ruled out or addressed'.*

This latter definition has been recommended by an international consensus committee (Basson et al., 2004). Although this definition is indeed more comprehensive and representative of the clinical picture, it is still problematic and requires empirical support (Reissing et al., 2004). Previous studies suggest that vaginismus occurs in approximately 0.5 to 1% of women of childbearing age. The ambivalence around a clearly agreed definition leads to considerable difficulty in estimating prevalence, culminating in a current lack of estimates for vaginismus (Graziottin, 2008). Dyspareunia is defined as *'recurrent or persistent acute pain associated with penile vaginal intercourse, with disturbance causing marked distress or interpersonal difficulty'* (Basson et al., 2004; Binik, 2010a). Like vaginismus the prevalence for this disorder is dependent on the definition for its diagnosis. However, evidence indicates that in women of childbearing age the prevalence of dyspareunia varies between 3-18% (in population based studies) (Hayes et al., 2006, 2008).

The distinction between vaginismus and dyspareunia is debated; with experts in the field suggesting the two to be collapsed into a single diagnostic entity called genito-pelvic pain/penetration disorder (DSM-5, proposed version) whereas others hold to the idea that these are two distinct disorders. Conceivably this distinction is well dependent on the criteria used for diagnosis, for instance, lifelong vs. acquired, generalized vs. situational, exclusively due to psychological factors or due to more combined factors. Complicating this distinction between primary vaginismus and female dyspareunia even further, is what we refer to as provoked vestibulodynia (PVD), in other words - pain that occurs in response to stimulation of the affected area. PVD is characterized by *'sever, chronic burning/superficial pain, localized to the vulvar vestibule, that occurs in response to pressure and/or penetration'* (Goldstein and

Pukall, 2009). Provoked vestibulodynia, formerly termed vulvar vestibulitis syndrome (VVS), is estimated to affect 12% of all women of reproductive age (Goldstein and Pukall, 2009).

For the purpose of the present research, in the vaginismus group we only included women with primary/lifelong vaginismus as the focal point of each clinical study included in this dissertation, together with a group of women with dyspareunia as a clinical control group. Inclusion criteria for the (acquired/lifelong) dyspareunia group were persistent or recurrent pain in at least 50% of attempted or complete vaginal penetrations and/or penile vaginal intercourse, with duration of at minimum 6 consecutive months. We included both deep (pain felt deep inside the pelvis during penetration) and superficial (pain felt at the introitus) dyspareunia. To achieve a highly homogenous cohort, no women included in the lifelong vaginismus group had a diagnosis or co- morbidity/secondary (of) PVD. Moreover, since vaginismus is given the main focus here, and due to the inconsistencies of the definitions used for this disorder, we considered it imperative to explicitly mention the boundaries used for the recruitment procedure of this group that we based each one of our clinical studies on.

### 1.1.2 Boundaries for the diagnosis of vaginismus

An experienced gynecologist and sexologist examined both clinical groups (i.e., lifelong vaginismus and dyspareunia), using a gynecological-sexual clinical interview routinely used in our department as part of the assessment and diagnostic procedure (de Jong et al., 2009; Borg et al., 2010, 2011; Huijding et al., 2011; Spoelstra et al., 2011). The clinical interview included questions about whether the women have ever tried and succeeded to insert a finger, penis or any other object (e.g., tampon) in her vagina. In addition, the diagnostic procedure included a physical examination following a thorough history of the participants (van Lankveld et al., 2010). During the physical exam the women were always accompanied by their partner or a suitable chaperone. To have a sense of control over the examination, preparation was done in advance by informing the woman that she has full autonomy to end the examination at any point in time. Furthermore, she was also reassured that a speculum was never used during the diagnostic procedure.

As a first step and as part of the educational gynecological -sexological examination the woman was given a hand-mirror and the gynecologist guided her through an anatomical description of her genital area using a moistened cotton swap to identify all structures. Once encouraged to feel as relaxed as possible, the woman was asked to press against the gynecologist finger - placed on the *hymen* (see Figure 1.1, vaginal anatomy with arrow illustrating the hymen). At this point, in women

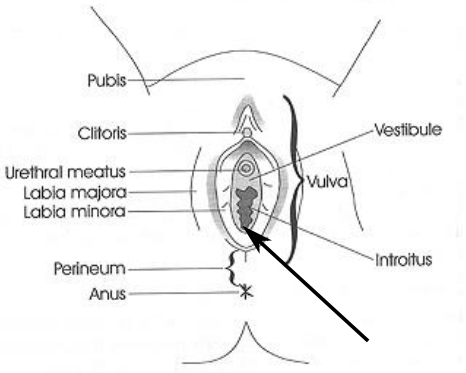



Figure 1.1: The arrow illustrates the hymen where the gynecologists places his/her finger during examination

with lifelong vaginismus the educative gynecological-sexual examination was usually terminated due to over-activity of the pelvic floor muscles and/or involuntary guarding behaviour. Inclusion in the lifelong vaginismus group was only possible when in the context of being assisted to relax, attempts to insert a finger into the vagina elicited an involuntary guarding reaction and a report of state fear at the attempt (or even the thought) of vaginal penetration during the gynecological-sexual exam. For the inclusion this guarding-avoidance behaviour had to be present also outside the clinic on attempts of vaginal penetration, together with the history of no previous vaginal penetration.

During the gynecological diagnostic exam (see Section 1.1.2), the women were encouraged and assisted to feel as relaxed as possible, only then the women were asked to press against the gynecologist finger placed on the hymen. The hymen is illustrated in this figure with a black arrow on the labeled vaginal anatomy.

## 1.2 Vulnerability and maintaining factors underpinning vaginismus

Varying mechanisms have been suggested to be implicated in vaginismus. In fact, this ill-understood disorder has been investigated from different points of view, both physiologically and within the framework of well-known psychological theories. In spite of this, the existing literature still does not point to one definite aetiology. In fact, up till now, though various anecdotal hypotheses exist in vaginismus research, very few have received reliable empirical support (Reissing, 2009). Many different

dynamics, and experiences can have an effect on the symptoms typically experienced by these women; varying from relationship dynamics (e.g., restricted sexual arousal towards the partner), negative experiences (e.g., sexual abuse, and painful previous attempts of intercourse), and dysfunctional beliefs (e.g., cultural norms, religiosity, and strict morality) - to one's actual (and perceived) level of sexual functioning. We here mainly focus on the factors that keep surfacing in research concerning vaginismus. These factors include: pain (fear of), strict morality, dysfunctional sex beliefs, and negative emotionality.

### 1.2.1 Vaginal penetration will be too painful

As I briefly mentioned earlier in this section, vaginismus is classified as a sexual dysfunction in the DSM-IV and is categorised under female sexual pain disorders (DSM-IV-TR, 2000). However, although vulvar pain is neither a necessary nor a sufficient prerequisite for the diagnosis of vaginismus, pain has for long been considered central in studies on the aetiology of vaginismus. Relevant here is that experts in the field also tap on the idea that vaginismus, dyspareunia or the broader term penetration disorders should be considered as pain rather than sex-related-disorders (Binik et al., 2010). Given this focus on the pain component in vaginismus research, as a starting point I will focus on the Fear-Avoidance model previously applied to chronic musculoskeletal pain. This model has recently been applied to sexual pain disorders such as vaginismus, since similar affective and cognitive processes also seem to be involved in the perception and maintenance of sexual pain (Reissing, 2009; Dewitte et al., 2011; Brauer et al., 2007; Desrochers et al., 2010) (see Figure 1.2).

In vaginismus, sexual pain or its anticipation may give rise to catastrophic ideation (e.g., vaginal penetration will be painful, penis is too large etc) and vaginal penetration-related fear (e.g., I was afraid my partner would accidently put his hand too near my vagina which would cause me to tense up) (Reissing et al., 2004; Reissing, 2009; ter Kuile et al., 2010). In turn, the anticipation of catastrophic consequences may well contribute to hyper-vigilance towards painful sexual stimuli. Thus, hypervigilance may not only lower the threshold for negative physical sensations, but may also contribute further to a negative appraisal of sexual cues, and avoidance (Lykins et al., 2011; Payne et al., 2005). Additionally, attempts of penetration that are met with increased muscle tone may add to the negative cognitions and confirm the negative expectations (e.g., indeed I was unable to have intercourse) which again confirms the negative experiences and keeps the women stuck in the vicious cycle described in the model (see Figure 1.2).

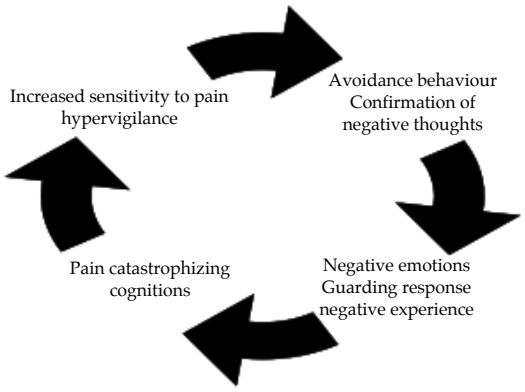



Figure 1.2: The vicious cycle of vaginismus. Adopted from Reissing (2009)

Relevant to this model is the evidence that people with sexual pain show heightened vigilance for coital pain and selective attention towards pain stimuli (Payne et al., 2005). As a result, one would expect that women who show a habitual tendency to make such catastrophic interpretations of pain are likely to also apply a similar strategy to situational pain during (attempts of) penetration. Accordingly, if indeed dysfunctional pain cognitions play an important role in the aetiology and maintenance of sexual pain disorders, women with high pain catastrophizing cognitions would be especially vulnerable for these symptoms. That said, previous research has not found this straightforward association with heightened levels of generalized pain catastrophizing cognitions in women with vaginismus.

One explanation could be that the relationship between generalized pain catastrophizing cognitions and the development of sexual pain during vaginal penetration is moderated by individuals' habitual sensitivity for signals of punishment (such as pain) often defined as harm-avoidance (Pud et al., 2004; Torrubia and Tobena, 1984; Torrubia et al., 2001). The trait harm avoidance will logically support pain avoidance, thereby preventing the disconfirmation of pain catastrophizing cognitions (Leeuw et al., 2007; Payne et al., 2005). In other words, it will eliminate experiences that can challenge the women's negative thoughts and thus only confirms the negative experience (Crombez et al., 2005). Consequently, the influence of trait pain catastrophizing would be especially prominent in generating persistent dysfunctional pain-related cognitions in women with relatively strong trait harm avoidance. If so, women with both high harm avoidance and high pain catastrophizing cognitions would be especially prone to develop vaginismus.

Given this framework, the first study of this thesis (see Chapter 2) examined whether women with vaginismus are indeed characterized by heightened levels

of both trait pain catastrophizing and trait harm avoidance. We aimed to explore whether these characteristics are restricted to lifelong vaginismus or whether they are more broadly involved in sexual pain disorders in general.

### 1.2.2 Transgression and sex related beliefs

In addition to traits of harm avoidance and pain catastrophizing cognitions, lack of open and complete sex education, that is sometimes driven by conservative religious beliefs, has been drawn in as contributing factors for negative emotional responding to intercourse and sex in general (Reissing, 2009). In fact what is considered as wrong-doing or transgression has also been indicated as a vulnerability factor for the symptoms associated with vaginismus (Reissing, 2009). In line with the same reasoning, evidence indicates that women with high devotion to conservative values are less tolerant to a range of sexual behaviours (Yasan and Akdeniz, 2009). Reduced tolerance towards various sexual expressions and behaviours logically restricts the sexual repertoire and will lower the threshold for experiencing negative emotions in a sexual context (Haidt and Hersh, 2001). In turn this may generate withdrawal and avoidance behaviour, which might very well disrupt sexual absorption and arousal.

This framework suggests that exploring the adherence to the women's moral values could be one pathway that may help to explain negative emotional responding towards particular sexual behaviours. Literature suggests that people with less liberal principles are assumed to attach little importance to indulgence, sensuality, and emotional gratification, whereas strong adherences to liberal values are associated with recognizing sex as an emotional release (Basson and Weijmar Schultz, 2007). The presence of more conservative moral principles, including limiting actions and impulses or a general difficulty with transgression, may play a negative role in sexual behaviour by limiting the sexual experience and the *'letting go'* or the *'I (totally) surrender'* feeling. Moreover, if these values have become ingrained in the women's system; in her core beliefs and perspective from an early age (e.g., through education, cultural rules, religion etc.) it might automatically elicit difficulties with sexual responding (de Jong et al., 2010).

Intertwined with the more general pattern of conservative versus liberal values, certain (negative) sexual beliefs can also have a more direct effect on the expression and responsivity to sexual stimuli. This entanglement of conservative values and strict sexual beliefs may well increase the vulnerability for developing sexual problems associated with disrupted sexual absorption or arousal. Consistent with this view, research has shown that women with sexual dysfunctions were indeed more conservative in their sexual beliefs (e.g., 'Masturbation is wrong and point-

less', 'Achieving an orgasm is acceptable for men but not women', and 'Anal sex is a perverted activity' (Nobre and Pinto-Gouveia, 2006). In the same vein, conservative religiosity was found to be a predictor of negative emotions after masturbation (Yasan and Akdeniz, 2009). Additionally, women with vaginismus report less self-stimulation, and a higher prevalence of problems with sexual desire and arousal (Reissing et al., 2004; Weijmar Schultz et al., 2005). This stand point (as detailed in Chapter 3) motivated us to examine whether higher adherence to conservative values may indeed be involved in vaginismus; and whether these alleged conservative standards are also evident in the domain of sexual behaviour.

### 1.2.3 Negative emotions towards sexual stimulation

In negative emotional responding surrounding sex, current views emphasize the role of pain and fear. Fear in effect has always surfaced as a top candidate in negative emotional responding (Barlow, 1986; Janssen et al., 2002a,b). However, what remains unanswered is the driving force behind this fear - is it fear of contamination, fear of pain, or the prospect of physical harm? Though, fear might be the dominant emotion, it is still unclear what actually is the motivating force or the foundation for this fear. Recently it has been argued that fear of contamination and the emotion of disgust may also be involved in vaginismus similarly to other specific phobias (e.g., spider phobia, blood injury phobia, etc.). For instance, spider phobia has been predominantly linked with disgust and disease-avoidance (de Jong and Muris, 2002; Matchett and Davey, 1991), whereas fear was still the prevalent emotion in the distress caused by exposure to the feared stimuli (de Jong et al., 2002).

Taking spider phobia as one representative example, research in this field also showed that disgust propensity was the best and single predictor of eliciting fear during spider exposure (de Jong and Muris, 2002). Here, we need to clarify that by this, I am by no means saying that the disease-avoidance conceptualization disputes fear as a dominant response, but implies that perhaps the core of the fear or its response is more related to unwanted contact with disgusting stimuli (van Overveld et al., 2006). In other words, fear could result from the anticipation of disgust related catastrophe such as contamination (Huijding and de Jong, 2006b). This entanglement is fuelled by evidence indicating that fear and disgust seem to be at least partially confounded (Woody and Teachman, 2002; Huijding and de Jong, 2006b) which makes it more complex to capture what is the actual drive of the expressed fear or catastrophe.

In vaginismus, or as it is recently referred to, in 'penetration-specific phobia' it can very well be that these women indeed express fear of a catastrophical outcome; but the anticipated catastrophe could perhaps be driven by contamination concerns

which triggers the spontaneous behaviour and avoidance reflexes to create distance away from the contaminant stimulus. In line with this proposed mechanism, disgust has been recently suggested to play a prominent role in the symptoms experienced by these women, and research from our lab revealed evidence indicating that women diagnosed with vaginimus - indeed were characterized by high levels of disgust propensity traits (see Section 1.3.2) (de Jong et al., 2010). Accordingly, because of the proposed role of disgust in vaginismus, I will follow this section by focusing on this emotion and its mechanisms.

## 1.3 Zooming into the emotion of disgust

In the previous section, I briefly brushed on the vulnerability and maintaining factors implicated in vaginismus and their relationship with negative emotional responding; here I depart from sexual problems, and mainly focus on the emotion of disgust as a unique entity.

Disgust has long been acknowledged as one of the six basic and universal emotions at least since Darwin's in 1872, who concisely referred to the elicitation of disgust as:

> *'... something revolting, primarily in relation to the sense of taste, as actually perceived or vividly imagined; and secondarily to anything which causes a similar feeling, through the sense of smell, touch and even of eyesight" (Rozin et al., 1999); experienced at: 'the threat of intimate contact with certain stimuli, and the more intimate the contact the higher the disgust response' (Fallon and Rozin, 1983; Fessler and Haley, 2006)*

.

In a more simple way the Collin's English dictionary defines disgust as:

> *'a great loathing or distaste aroused by someone or something (Raphael, 1998).*

Disgust is usually said to be recognized across cultures (Ekman et al., 1987) and to a certain extent shaped by societies over time (Sawchuk et al., 2000). It is defined by the typical facial expressions (e.g., wrinkle of the nose, raise of the upper lip and pulling down the corners of the mouth), and by specific neurophysiological signs (e.g., nausea, and changes in skin conductance) (Alaoui-Ismaili et al., 1997; Palomba et al., 2000). Besides, in the more recent years disgust has been consistently associated with specific neural correlates (Murphy et al., 2003; Phan et al., 2002; Zald and Pardo, 1997). However, the specific neural response largely depends on the type of disgust elicitors, and whether the participant is asked to recognize a disgust response, or else to actually feel and respond with disgust (see Section 1.4.1). In terms

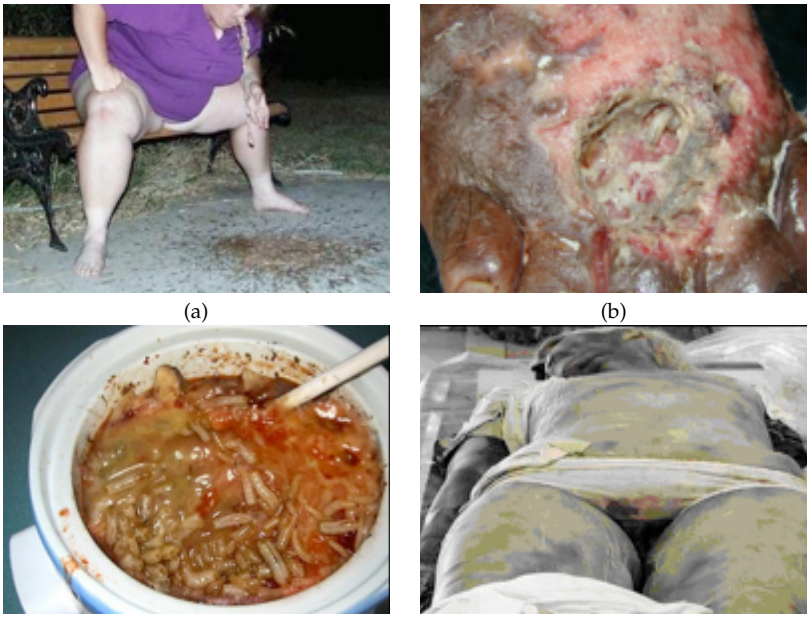
of behaviour the distinctive disgust response generally triggers escape and avoidance tendencies. Additionally, with undesirable contact or incorporation of disgusting stimuli it may give rise to defensive reflexes in order to create distance (away) from the perceived contaminant (Rozin and Fallon, 1987; Olatunji and Sawchuk, 2005).

### 1.3.1 Elicitors of the disgusting and revolting!

If we move beyond the primary function of disgust as *'a guardian of the mouth'*,- which is more linked to distaste - toward the most abstract *'a mechanism for avoiding harm to the soul'*, we can understand that disgust has extended and expanded in many directions. On the same lines, disgust seems to respond to numerous and heterogeneous sets of elicitors. Consequently, there are various theory-driven classification systems that differentiate in how to best categorize clusters of disgust eliciting stimuli, and the labels of disgust sub-domains might be perplexing and at times conflicting. Having said that, it is indisputable that the whole range of disgust eliciting stimuli seems to cluster in coherent sub-domains of disgust. Each of these domains has been proposed to relate to a qualitatively different adaptive problem (Curtis et al., 2011). The following section is aimed to concisely portray the dominant disgust models and to briefly outline the convergences in their classification system of disgust elicitors, using the conventional disgust-domain classification of Rozin et al. as a starting point (Rozin et al., 1999). I will keep in line with available empirical evidence for differentiating between various types of disgust elicitors. However, I do not intend to elaborate on the strengths and weaknesses of different theoretical models and classifications here; interested readers can find further literature about these classifications elsewhere (Tybur et al., 2009; Curtis et al., 2011; Oaten et al., 2009; Rozin et al., 1999).

#### Dominant classification systems

In their seminal review Rozin and Fallon, argued that disgust can be differentiated in four categories or domains; namely, core, animal-reminder, interpersonal and socio-moral disgust elicitors (Rozin et al., 1999). Core disgust is characterized by perceived threat of oral incorporation, such as, rotten food, bodily waste products and small animals; animal-reminder disgust elicitors consist of stimuli that reminds us humans, of our intrinsic animalistic nature or the similarities we share with animals, such as specific sexual behaviour, violations to the outer body envelope, and death (see exemplars in Figure1.3); Interpersonal disgust is typically elicited by contact with foreign and ill individuals; and finally socio-moral disgust is a response to a violation of our moral boundaries such as when a person is referred to as morally



(a) (b) (c) (d)

Figure 1.3: Examples of pathogen disgust stimuli. First column shows examples of core disgust elicitors, and second column shows examples of animal-reminder (A-R) disgust elicitors.

insane. Whereas according to Tybur's classification the whole range of disgust elicitors are divided in three coherent (broader) domains that are: pathogen-, sexual-, and moral disgust (Tybur, 2009; Tybur et al., 2009).

The least controversial disgust domain surrounds the core disgust elicitors. Several theorists readily agree that his type of disgust has evolved as a disease-avoidance mechanism (Curtis et al., 2011). Pathogen disgust or core disgust, evolved to protect humans from contamination by infectious and toxic agents (Curtis et al., 2011; Oaten et al., 2009), by readily rejecting contact and/or ingestion of pathogen-based disgust stimuli. Consistent with such a disease-avoidance conceptualization, core disgust is typically focused on the intersection between the body and the outside pathogens (Fessler and Haley, 2006; Rozin et al., 1995). Providing further support for the view that pathogen disgust guards us against disease - is found in the variability of women's disgust propensity levels: with highest scores during the luteal phase of the menstrual cycle when the vulnerability to disease is relatively high due to a down-regulation of inflammatory immune responses (Fleischman and Fessler, 2011); and relatively high during the first trimester of pregnancy when mother and fetus are most vulnerable to disease (Fessler et al., 2005).

When we divert our attention toward animal-reminder disgust category, this could easily be perceived as the most complex to define - at minimum in terms of function. The view of Rozin's on animal-reminder disgust as a separate domain indeed has systematically been found to reflect a separate cluster of elicitors. However, the very function as described in his seminal work might not be completely plausible (interested readers might want to read Tybur et al. 2009, for a critical evaluation of this discussion). Perhaps, animal reminder disgust (e.g., mutilated bodies, corps etc.) is another category of stimuli that also informs us about potentially disease inflicting agents. This is strengthened by relatively high correlations between these two categories (animal-reminder, core) on the Disgust Scale (see Section 1.3.2). Nevertheless, here it is important to mention the work of Bunmi Olatunji and colleagues among others, that in line with the two-stage model of disgust highlights the importance to differentiate within the cluster of pathogen disgust elicitors, which are, core and animal-reminder (Olatunji et al., 2008). In these studies it is strongly indicated that these domains of disgust can be distinguished as two separate constructs. Moreover, they are not only the two constructs most widely established in literature, but also consistently found to be differentially involved in various psychopathologies. Therefore, I will mainly focus on these two categories of disgust elicitors; however I consider it relevant to nonetheless briefly explain the remaining categories of disgust domains.

Sexual disgust in Tybur's classification is virtually identical to what in Rozin's classification system is labeled as 'interpersonal disgust' - but one can say that sexual disgust to a certain degree is more specific. Important to explicitly mention here that though the name of this category can incline the reader to perceive this cluster as disgust elicited during sex; in actual fact it refers to disgust elicited merely by potential sexual mates. For instance, this type of disgust is elicited if someone had to ask you to have sex with a sibling or immediate relative (Lieberman et al., 2007). In addition, just to emphasize that this type of disgust is solely elicited in a sexual scenario, someone can easily have pleasurable time (also with physical contact or in close proximity) with a colleague or friend but if asked to have sex or intensions move in that direction from one part, there is room for sexual disgust from the other part. Possibly, this type of disgust evolved to facilitate avoidance of sexual partners that challenge long-term reproductive success (e.g., high genetic similarity of close relatives and low intrinsic qualities of a potential sex mate reflected in abnormal or less than attractive physical features) (Thornhill and Gangestad, 2006). Thus, sexual disgust will typically be elicited via (the prospect of) physical (and intimate) contact with another person, instead of through being in contact with particular stimuli. Another feature of this category is that the disgust-eliciting properties of these potential mates are restricted to the sexual context. It should be pointed out, that

there is no much empirical support defining the category of interpersonal disgust of Rozin's classification as a separate category of elicitors; possibly because this cluster is elicited by a number of other stimuli that also make part of the other categories (e.g., partly core, partly animal-reminder, etc.).

The last category I would like to discuss here is moral disgust. There seems to be consistent agreement between both theoretical perspectives and empirical evidence, particularly in terms of how different this category is from core/pathogen disgust. This cluster of stimuli reflects socio-moral transgressions, possibly evolved to motivate avoidance of social relationships with norm-violating individuals (Schroeder, 2012; Tybur, 2009; Tybur et al., 2009). Thus, the defensive mechanism of disgust originally evolved to protect the (physical) integrity of the individual, seems extended to also secure the integrity and boundaries of individuals' social networks (Rozin et al., 2009, 1999). Quite interesting is recent evidence demonstrating that the prospect of transgressing socio-moral rules may give rise to intense feelings of disgust, and it has been shown to elicit the same levator labii responsivity and behavioural responses as seen in core/pathogen/disease-avoidance disgust (Chapman et al., 2009; Zhong and Liljenquist, 2006). Moreover, the experience of disgust itself may further shape and strengthen people's moral values. In other words if you are morally more on the strict side in terms of moral standards or more devoted, when disgusted the already present moral standards are emphasized and thus so is the perception of wrong-doing/transgression.

### 1.3.2 Disgust traits and states

Disgust not only can be differentiated along the dimension of disgust domains or in terms of cluster of elicitors, but also like other basics emotions it encompasses - a state and a trait component. These two concepts refer to characteristics that are variable and tend to change depending on context (state) versus characteristics that are more stable (traits). Situational disgust can be defined as the direct (here and now) experience of disgust and can be both external (e.g., you open the door of the WC and are faced with a very dirty toilet) as well as internal (e.g., remembering when you took a bite from a kiwi that was rotten) (van Overveld et al., 2009). This type of disgust (state-disgust) is highly associated with avoidant tendencies and defensive reflexes (e.g., withdrawing attention or completely avoiding the situation), that may help to protect and to avoid (the anticipated) contamination. In other words, state disgust guides more the spontaneous kind of behaviour. Whereas, disgust traits involves individual differences concerning people's threshold for experiencing disgust (propensity), as well as regarding their appraisal of the experienced disgust responses (sensitivity). That is, people not only vary in their tendency to experience

the emotion of disgust more readily, but also in their tendency to how they find the emotion of disgust unpleasant. High disgust propensity may increase the probability that stimuli acquire disgust-evoking properties which could lead to avoidance behaviour (de Jong and Muris, 2002). In turn this avoidance would be especially pronounced in individuals who appraise the experience of disgust as highly negative (van Overveld et al., 2010).

Attesting further to the relevance of differentiating between disgust propensity and sensitivity, both traits have been shown to be diversely involved in psychopathology (Engelhard et al., 2011; Olatunji et al., 2007). For example disgust propensity trait is implicated as vulnerability factor for spider phobia and maintaining factor for obsessive compulsive disorder- of the contamination subtype (Olatunji et al., 2007), and eating disorders (Power and Dalgleish, 1997; Troop et al., 2000); whereas trait disgust sensitivity seems to be especially relevant for psychopathologies that are related to intrinsically disgusting stimuli, such as those involving vomit and blood (e.g., blood injury phobia) (Schienle, Schafer, Walter, Stark and Vaitl, 2005; Sawchuk et al., 2000). This differentiation between disgust traits is also marked at brain level, in that disgust-related brain responses that correlate with propensity disgust trait include the insula, ventral pallidum and occipitotemporal cortex (Calder et al., 2007; Mataix-Cols et al., 2008; Schaefer et al., 2009; Schienle, Schafer, Walter, Stark and Vaitl, 2005), whereas sensitivity disgust trait was negatively associated with medial and dorsolateral prefrontal activity (Schaefer et al., 2009). This differentiation that in itself illustrates differential brain networks that are involved in various types of disgust could help to explain diverse processes or features that may be critically involved in each of these domains. Both the stable disgust traits as well as the more variable disgust state might be involved in the symptomatology associated with vaginimus, but logically we have to use different measurements to capture states and traits.

**Disgust scale-revised**

To measure individual differences towards these disgust domains, we have the widely used disgust scale (Haidt et al., 1994; Rozin et al., 1999). Olatunji and colleagues removed the seven items that detracted from the reliability of the original disgust scale developed by Haidt (Haidt et al., 1994) and left three distinct domains of disgust elicitors. Thus the revised version of the disgust scale includes animal-reminder, core, and contamination disgust subscales (Olatunji et al., 2007). In our research we only make use of the revised version of the disgust scale (see Appendix 1.A.) for the Disgust Scale Revised (van Overveld et al., 2010). The three subscales included in the revised version, correspond well with the disgust classification out-

lined by Rozin and colleagues (see Section 1.3.1) (Rozin et al., 1999). Concretely, the core and animal-reminder have the same label whilst the DS-R contamination subscale seems to capture both domains of interpersonal and socio-moral disgust dimensions as described by Rozins' classification (Olatunji et al., 2008). One could think that the actual label might in fact be problematic here, or at least not precise, as it seems to suggest that the other domains (or sub-scales) do not relate to contamination, whereas in fact the contamination scale seems least involved in contamination properties.

The DS-R scale is particularly helpful in illustrating the divergence of these constructs but perhaps more importantly it gave us insight in how these domains are differentially involved in specific psychopathologies.

## 1.4 Intermezzo: neuro-processing of disgust and disorder specific stimuli

Staying in line with the theory of disgust-based mechanisms, and its implication in psychopathology, I now divert attention to the neurophysiological underpinnings of disgust. Applying functional magnetic imaging (fMRI) in an attempt to understand disgust responding will provide us with the opportunity to set the stage for the final step, to investigate whether women with vaginismus would indeed show a different pattern of activity to disorder-specific stimuli - that would more strongly resemble disgust responses when compared to the other two groups (i.e., dyspareunia and women with no sexual problems). In order to do this we have included two other (secondary) studies. 1) In the first study, I attempt to tap on the neural correlates of disgust as a function of the disgust domain (core, animal reminder) and as a function of trait disgust (propensity, sensitivity); whilst in the second peripheral study, 2) I investigated how women respond to penile-vaginal penetration pictures as disorder-specific stimuli.

I consider this intermezzo necessary for a full appreciation of the role of disgust, the disgust-based brain mechanisms, and the neural processing of the disorder specific stimuli. Meanwhile, these studies might also be relevant for a comprehensive appreciation of the neural processing - as an objective measure of the stimuli we used in the empirical chapters included in this dissertation.

### 1.4.1 Disgust domains in the brain as a function of disgust traits

In the pool of literature about emotionality, we repeatedly read that there is limited brain research on disgust compared to other basic emotions, but more limited are the studies that took disgust domains into account - especially at brain level. That said, recent evidence indicates that core and animal-reminder-like disgust experiences draw upon distinct peripheral physiological activity and separable responses in the anterior insula (Harrison et al., 2010), whereas core disgust have been shown to elicit differential activation at the level of the amygdala (Moll et al., 2005; Schaich Borg et al., 2008). In direct comparisons between animal-reminder and core conditions, brain responses to animal-reminder-like stimuli (e.g., mutilation) tend to be stronger, most notably in occipitotemporal (Sarlo et al., 2005) and parietal cortices (Schienle et al., 2006; Wright et al., 2004). In line with previous physiological and subjective evidence, this gives us insight that even at the central level; core and animal-reminder-like disgust responses can be differentiated as two separate constructs, despite being two kinds or domains of pathogen-based/disease-avoidance disgust (Harrison et al., 2010; van Overveld et al., 2009). Notable is the fact, that stimuli in these earlier studies may have been suboptimal, in that they had not meticulously represented and distinguished animal-reminder and core disgust (see exemplars in Figure 1.3). Additional complexity is introduced when we consider that individual differences in disgust traits have been found to critically modulate subjective and physiological disgust responses (van Overveld et al., 2009), and that these traits seem to interact with disgust domain in the vulnerability and maintenance of psychopathological symptoms (de Jong and Merckelbach, 1998; Olatunji et al., 2005; Sawchuk et al., 2000). All these accounts support the claim that disgust extends far beyond the mere role of a mouth guardian. More critical here is that disgust responses seem domain-specific, and people show differences in their responsivity to potential disgust elicitors as well as in their appraisals of the experience of disgust. The (potentially) important interaction between specific disgust traits (propensity, sensitivity) and disgust domains (animal-reminder, core) has so far been largely overlooked. Therefore, in Chapter 5, we included these angles and we aimed to search for brain mechanisms that express an interaction between disgust domain (animal-reminder, core) and putative disgust traits (sensitivity, propensity).

### 1.4.2 Neural correlates of disorder specific stimuli

As an important next step it would be relevant to investigate how women with no sexual problems respond to penetration stimuli at neural level. We can have insights in the appraisal of these stimuli by studying their corresponding motivational

approach or withdrawal responses by various methodologies (e.g., reaction time tasks, subjective reports, physiological measures etc.). However, applying functional magnetic imaging techniques to understand the neural mechanisms, as we earlier pointed out in this introduction - gives us probably a unique opportunity to investigate the 'capturing' of these stimuli; and also to evaluate to what extent, the response to this cluster of specific sex stimuli (penetration specific, PEN) is in general different from - or similar to the neural responses toward disgusting stimuli (in line with the theory proposed throughout this chapter).

This is first done only with women who have no sexual dysfunctions but it will help us to pave the way to design the critical test to investigate whether women specifically inflicted with vaginismus respond similar to sex pictures as to (particular types of) disgusting stimuli. Thus, this first part of the study, leads us to the study included in Chapter 6, where we aimed to comprehensively assess how explicit and implicit attitudes toward PEN stimuli relate to PEN-induced brain activity.

#### Specificity of disorder-specific stimuli

There is huge variability in sexual stimulation that has been used in research studies - from single nudes, to couples, and erotica (Childress et al., 2008; Sescousse et al., 2010). We were primarily interested in this selected cluster of stimuli namely, penile-vaginal penetration stimuli with limited context, mainly due to its specificity for vaginismus. Of course this study is not only relevant for the present project but might more generally contribute to our understanding of how women process this cluster of stimuli that can also be conceptualised/interpreted as a kind of visual hardcore pornography.

## 1.5 Spontaneous vs. edited disgust response to disorder specific stimuli

I will now re-focus to apply the disgust based mechanisms - discussed in detail throughout this introduction to sexual pain disorders, particularly to vaginismus.

Because of the renowned role of disgust as a defensive mechanism to protect us against contamination (Rozin et al., 1995), it logically centers on the intersection between the body and what is in the outside environment. Moreover, disgust responsivity increases as a function of proximity of the potential contaminant and the sense of inclusion (Rozin et al., 1995). Therefore, given the core role of particular body parts high on disgust sensitivity and their products generally considered among the strongest disgust elicitors in sexual behaviour, we can quickly under-

stand how these stimuli can acquire disgust properties to the altitude that disturb functional sexual absorption.

The situational disgust as brushed on in the previous section (see Section 1.3.2) is highly associated with avoidant tendencies to keep away from (the anticipated) contamination. For instance the anticipation of vaginal penetration may well elicit involuntary pelvic floor muscle activity, as a (state) disgust response to readily create distance from the perceived contaminant or threat catastrophe, which has been shown to be part of a general defence mechanism (van der Velde et al., 2001). From this perspective, vaginismus may at least be partly due to a disgust-induced defensive response. By definition high levels of individual disgust traits (especially disgust propensity) lowers the threshold and makes it more likely to experience situational disgust. In support of the hypothesis that disgust responsivity might be involved in vaginismus, we have preliminary evidence from our laboratory that women diagnosed with vaginimus are characterized by generally enhanced levels of trait disgust propensity (de Jong et al., 2010). However, a critical point here is that enhanced trait disgust propensity does not imply that these women as a result also show higher disgust responsivity to sex related (disorder-specific) stimuli. Hence, an important next step would be to test whether indeed women with vaginismus would show enhanced disgust responding towards penile-vaginal penetration specific stimuli.

### 1.5.1 Dual-process model applied to disgust-mechanisms in vaginismus

In addition, current dual process(ing) models emphasize the importance to differentiate between more deliberate, reflective attitudes and automatic reflexive associations in memory (Gawronski and Bodenhausen, 2006). Both types of cognitions are believed to have different functional qualities and both operate behind the scene for behaviour that is more evident. Explicit cognitions tend to lead to the edited and deliberate behaviours, whereas the so called automatic associations seem to play an important role in impulsive behaviours, the kind of behaviours that seems to also be critically involved in disgust and/or threat induced defensive behaviour (Huijding and de Jong, 2006a, 2007). Therefore, it might well be that uncontrollable, automatically activated associations are a crucial factor in eliciting the characteristic defensive reactions in women inflicted with a diagnosis of vaginismus.

### 1.5.2 Neuro-psychophysiological measure of disgust in vaginimus

Therefore based on the theoretical frame of how disgust mechanisms can be implicated in vaginimus, described in Section 1.5, as a logical next step in Chapter 4, we present a study were it was aimed to index the initial disgust and threat-related associations in response to pictures showing sexual intercourse as disorder specific stimuli by using a reaction-time task, namely, single target Implicit Association Task (st-IAT). Moreover, in the same chapter, as a further (implicit) measurement of the role of disgust responsivity, we also recorded facial electromyography (EMG) of the facial levator labii muscle as a physiological marker of disgust (the nose wrinkle) (Vrana, 1993).

As a further next step, we wanted to understand whether this disgust-based response is also radiated to the neural correlates in women with sexual pain disorders (that is vaginismus and dyspareunia). Specifically, in Chapter 7, we designed a study to investigate the response to disgust stimuli but also to fear and disorder specific stimuli in women with sexual pain disorders, in order to understand if disgust is indeed involved in the psychopathology of vaginismus and/or if women with vaginismus respond with more disgust and/or fear to sexual penetration compared to women with dyspareunia and to women with no sexual problems.

## 1.6 Reciprocity of disgust and sex

> *'Sex can be, well, kinda gross. So how do we have sex? Once we're turned on, it turns out; it gets harder for icky stuff to turn us off. Women, anyway! Gross things just don't seem as gross when gals feel amorous' Chiant, 2012 in Scientific American*

In a nutshell as we explained in Section 1.5 of this introduction, disgust concentrates on the skin and body apertures with the mouth, and vagina being the body parts holding the highest subjective disgust sensitivity possibly due to their (intimate) apertures (Fessler and Haley, 2006; Rozin et al., 1995). Moreover, there is what Paul Rozin refers to as symmetry between these body parts that hold high sensitivity when on one's own body to high contamination potency when on some else's body (Rozin et al., 1995). Knowing the central role of these body parts in sexual behaviour, together with the fact that sex-related body products (e.g., vaginal fluids, saliva, semen) and smells (e.g., sweat) are among the strongest disgust elicitors (Rozin and Fallon, 1987), it is highly conceivable that there are ample space and opportunities for feelings of disgust to arise during the initiation of sex (de Jong et al., 2013). Therefore, when we consider the indubitable possibilities of how sexual

stimuli can give rise to feelings of disgust, not only can we understand how disgust may be involved in sexual dysfunction as indicated in the previous sections, but it also gives rise to a critical question about how it is still possible that people generally have a strong appetite for sex, and manage to willingly engage in pleasurable sex despite this emotional barrier that works against it.

Logically similar to disgust, sexual behaviour has an important evolutionary relevance. Consequently some mechanism must have been evolved to balance the opposing forces of the adaptive goal of reproducing with a high value partner for optimal genes, against the adaptive relevance of a disgust mechanism to avoid disease and contamination. It has been argued that in doing so, sexual arousal might temporarily reduce the disgust eliciting properties of otherwise disgusting stimuli (Stevenson et al., 2011). Coupled to this, a recent study investigated whether sexual arousal induced by passive erotic picture viewing, may indeed reduce the disgust properties of specific stimuli in male participants (Stevenson et al., 2011). Interestingly, participants in the experimental group reported being less disgusted by sex-related disgust elicitors than participants in the control conditions. Consistent with this, a correlational study showed that both men and women reported less disgust after watching an erotic movie (Koukounas and McCabe, 1997).

However, though these mentioned studies seem to give us some indications of why people still approach particular stimuli, what remains unanswered thus far is whether these findings are restricted to subjective feelings about imagined situations or if sexual arousal would be successful in increasing people's willingness to actually approach initially disgusting stimuli. The approach tendencies are particularly relevant here since disgust characteristically create distance from the disgusting stimuli in order to avoid contact with the (perceived) disgusting stimuli and thus could interfere with (functional) sexual behaviours. This is especially important in sexual disorders such as vaginismus when they are typically characterized by avoidance behaviour. Moreover, these earlier findings on the impact of sexual arousal on disgust were predominantly restricted to men (Ariely and Loewenstein, 2006; Stevenson et al., 2011). Given the evolutionary differential roles of men and women, women's higher sensitivity to disgust (Haidt et al., 1994; Fessler et al., 2005), their higher vulnerability to infections (Salvatore et al., 2011) and our line of research, it would be important to investigate whether these findings are also robust in a female sample.

This led us to the study in Chapter 8, were we aimed to test whether (also) in women this reduction in disgust properties would be restricted to sexual stimuli or would represent a more general phenomenon that also applies to disgusting stimuli in general. More critical here is whether sexual arousal would also facilitate participants' actual approach toward disgusting stimuli (see Chapter 8). This study might

also provide leads that help explain the sexual problems associated with sexual dysfunctions or more specifically with sexual pain disorders such as vaginismus. For instance, it could be that for a subgroup of women - sexual arousal does not result in a reduction of disgust feelings or in an attenuation of the disgust related avoidance tendencies. This would thus disrupt sexual arousal and would interfere with functional and pleasurable sex.

## 1.7 Dissertation organization, delineating the main research questions

The material following the introductory chapter in this dissertation can be globally divided in four main sections as detailed below:

**Section 1**

Chapter 2 is devoted to the relationship between the individual traits of harm avoidance and pain catastrophizing cognitions in female penetration disorders; 1) Are women with vaginismus indeed characterized by heightened levels of both trait pain catastrophizing and trait harm avoidance? 2) Are these characteristics (if present), restricted to lifelong vaginismus or are they more broadly involved in penetration disorders in general? As outcomes measures we used the Harm Avoidance scale of Cloninger's Tridimensional Personality Questionnaire, and the Pain Catastrophizing Scale in 3 groups of women (i.e., dyspareunia, lifelong vaginismus and women with no sexual complains).

Chapter 3 is based on the theory explained in Section 1.2.2 examines whether in fact strong devotion to conservative morals and/or strict sexual standards may be vulnerability features in penetration disorders; 1) Are higher adherence to conservative values indeed involved in vaginismus? 2) Are these alleged conservative standards also evident in the domain of sexual behaviour? We here used the Schwartz Value Survey (SVS) to investigate the individual's value pattern and the Sexual Disgust Questionnaire (SDQ) to index the willingness to perform certain sexual activities. The latter had the purpose to measure the indirect sex-related moral standards.

Chapter 4 is devoted to the effect of negative emotional responding to visual sexual stimuli in women with vaginismus; 1) Do visual sexual stimuli elicit automatic disgust-related (and/or threat related) memory associations in women with sexual pain? 2) Do these stimuli elicit physiological disgust responses and/or a deliberate expression of disgust and/or threat in women with penetration disorders. 3) Are these enhanced disgust responses (deliberate and/or implicit) present

solely in women with vaginismus or is it a mechanism that translates also to dyspareunia? We here used a single target Implicit Association Task (st-IAT) to index the initial disgust (and threat) automatic association in memory with sexual penetration. Moreover, in the same chapter, as a further (implicit) measurement of the role of disgust responsivity, we also recorded facial electromyography (EMG) of the levator labii muscle as a physiological marker of disgust.

**Section 2**

Chapter 5, is in line with the idea that disgust responses appear to be domain-specific and that people show individual differences in their responsivity to potential disgust elicitors. We here aimed to observe the brain mechanisms that express an interaction between disgust domain (i.e., animal-reminder and core elicitors) and the individual disgust traits (sensitivity, propensity); 1) are the neural networks associated with animal-reminder and core disgust elicitors distinctive/differentiated? 2) How are these brain responses explained by the individual disgust traits? We here used functional magnetic resonant imaging, and the Disgust Propensity and Sensitivity Scale (DPSS-R) that measure trait disgust propensity and trait disgust sensitivity.

Chapter 6, investigates how brain responses to disorder specific (sexual penetration) stimuli (PEN) are modulated by the initial associations in memory (PEN-'hot' versus PEN-disgust); 1) where in the brain are areas particularly sensitive to individual variations in implicit PEN-disgust relative to PEN-'hot' associations. 2) To what extent individual variability in sex stimulation-induced brain activity could be explained by the participants' positive and negative appraisals? For this study, we relied on a group of healthy young women with no sexual problems, and used functional magnetic resonance imaging (fMRI) and a reaction-time task, namely, a stIAT, with such disorder specific (sexual penetration) stimuli.

**Section 3**

Chapter 7, includes the core study, were we investigate the hemodynamic responses towards: disgust, fear, as well as toward penile-vaginal penetration-specific stimuli as a function of group (vaginismus, dyspareunia, women with no sexual problems); 1) do penetration-relevant stimuli particularly in the vaginismus group elicit disgust-induced brain activation? 2) Is the alleged enhanced affinity to respond to disgust specific for sex-stimuli or does it represent a more general inclination to experience disgust? 3) We here used passive viewing of disgust and fear elicitors, together with penetration specific stimuli in an MRI scanner.

**Section 4**

Chapter 8, presents a study where we investigated the effect of induced sexual arousal on the feelings of disgust and the actual approach tendencies to these initially disgusting stimuli; 1) is the influence of sexual arousal on the subjective feelings of disgust in our cohort of healthy young women the same as already found in male participants? 2) Is this effect only at subjective level or does sexual arousal also facilitates participants' actual approach towards these initially disgusting stimuli. 3) Is the hypothesized impact of sexual arousal restricted to sexual stimuli or does it represent a more general phenomenon that applies to disgusting stimuli in general?

**Samples we used for Chapter 2 to Chapter 8**

To briefly give the reader a global understanding of our samples used in these studies: For Chapter 3 and Chapter 4 we used a sample of women with vaginismus, dyspareunia and healthy controls who were recruited from year 2005 to 2009. In the meantime, in October 2009, we started recruitment for an independent sample of women diagnosed with either vaginismus or dyspareunia and healthy controls for the FMRI study. This was a slow process due to the nature of the sample we used, particularly so, because the prevalence of primary vaginismus is 0.5 to 1.0% of all women of childbearing age. In addition, we also had a number of exclusion criteria (among others, free of psychotropic drug treatment and MRI compatibility) that made this recruitment a rather lengthy process (2009-2013). However, during the course of this process we combined the earlier recruited sample with the women that we had recruited till then and investigated their traits of harm avoidance and pain catstrophizing cognitions (sample of Chapter 2). Also, we utilized our healthy controls that we eventually used for our main study (i.e., Chapter 7 in two chapters (i.e., Chapter 5 and Chapter 6). When we finally had recruited the planned number of women diagnosed with either vaginismus or dyspareunia, the complete sample of symptomatic women together with the women without sexual problems (the sample of healthy controls) were included in the final fMRI study that is reported in Chapter 7. The study included in Chapter 8 was done with an independent (student) sample.

**Summary and general discussion**

Chapter 9, includes the general discussion of the main findings presented in the empirical chapters (Chapters 2-8). The outcome of the discussion will be focused on the three following main questions; 1) Are the studied individual traits (e.g., pain catastrophizing, harm avoidance) and/or a strict conservative attitude along with specific beliefs surrounding sex involved as vulnerability and/or maintaining fea-

tures for the symptoms associated with sexual pain, particularly in vaginismus? 2) Is a disgust-based mechanism indeed implicated in vaginismus? If the latter is true, is this disgust mechanism expressed at the explicit level similarly to how it is at the more implicit and central level? 3) Is the natural disgust (and disgust properties) of generally avoided sex and non sex related stimuli attenuated with sexual arousal? Could this be the process that makes us actually come in contact with such stimuli? Moreover, limitations of the experimental studies will be outlined and integrated with plans for future research directions and follow up studies that are in the pipeline.

## Appendix 1.A. Disgust propensity and sensitivity scale - revised (DPSS-R)

**Instructions:** *this questionnaire consists of 12 statements about disgust. Please read each statement and think how often it is true for you, then place a 'x' in the box that is closest to this.*

1. I avoid disgusting things
2. When I feel disgusted, I worry that I might pass out
3. It scares me when I feel nauseous
4. I feel repulsed
5. Disgusting things make my stomach turn
6. I screw up my face in disgust
7. When I notice that I feel nauseous, I worry about vomiting
8. I experience disgust
9. It scares me when I feel faint
10. I find something disgusting
11. It embarrasses me when I feel disgusted
12. I think feeling disgust is bad for me

**Scoring key:** *never = 1, rarely = 2, sometimes = 3, often = 4, always = 5. Disgust propensity: sum of items 1, 4, 5, 6, 8, 10. Disgust sensitivity: sum of items 2, 3, 7, 9, 11, 12.*

# Section I

# Vulnerability and maintaining factors in vaginismus

# Chapter 2

# Harm avoidance and pain catastrophic cognition

**Abstract**

*Catastrophic appraisal of experienced pain may promote hyper-vigilance and more intense pain, whilst the personality trait of harm avoidance might prevent the occurrence of correcting such experiences. Women inflicted with vaginismus may enter a self-perpetuating downward spiral of increasing avoidance of (anticipated) pain. Specifically, in vaginismus the anticipation of pain may give rise to catastrophic pain ideation. This may establish hyper-vigilance towards painful sexual stimuli, which consequently results in negative appraisal of sexual cues and/or withdrawal. This process could impair genital and sexual responding, intensify pain and trigger avoidance, which in turn may contribute to the onset and persistence of symptoms in vaginismus and to certain extend also in dyspareunia. The aim of the study is to investigate whether women suffering from vaginismus are characterised by heightened levels of habitual pain catastrophic cognitions, together with higher levels of harm avoidance. This study consisted of three groups; a lifelong vaginismus group ($n = 35$, mean age = 28.4; SD = 5.8) a dyspareunia group ($n = 33$, mean age = 26.7; SD = 6.8) and women without sexual complaints ($n = 54$, mean age = 26.5; SD = 6.7). All participants completed the Harm Avoidance scale of Cloninger's Tridimensional Personality Questionnaire (HA), and the Pain Catastrophizing Scale (PCS). Specifically women inflicted with vaginismus showed significantly heightened levels of catastrophic pain cognitions compared to the other two groups, as well as significant enhanced harm avoidance vs. the control group, and a trend vs. the dyspareunia group. Both traits were shown to have cumulative predictive validity for the presence of vaginismus. This study focused on the personality traits of catastrophizing pain cognitions and harm avoidance in women with lifelong vaginismus. Our findings showed that indeed, women suffering from vaginismus are characterized by trait of harm avoidance interwoven with habitual pain catastrophizing cognitions. This study could help in the refinement of the current conceptualization and might shed light on the already available treatment options for women with vaginismus. Clinical implications that surface from our results are discussed.*

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## 2.1 Introduction

In the current version of the Diagnostic and Statistical Manual for Mental Disorders fourth edition [DSM-IV-TR] vaginismus falls under the umbrella of sexual pain disorders (DSM-IV-TR, 2000). In the present study, we used the definition suggested by an international consensus committee, which more comprehensively describe vaginismus as *'persistent difficulties to allow vaginal entry of a penis/finger/object, despite the woman's expressed wish to do so. There is a variable involuntary pelvic floor muscle contraction, (phobic) avoidance and anticipation/fear/experience of pain (p. 45)'* (Basson et al., 2004). Vaginismus occurs in approximately 0.5 to 1% of women of childbearing age, though accurate estimations are lacking (Graziottin, 2008). Although pain is not required for the diagnosis of vaginismus, women inflicted with this disorder typically report pain; for instance, with vaginal palpitation during the gynecological examination (Reissing et al., 2004).

Recently, it has been argued that the Fear-Avoidance model previously applied to chronic musculoskeletal pain can be applied to sexual pain disorders such as vaginismus, since similar affective and cognitive processes seem to be also involved in the perception and maintenance of sexual pain (Reissing, 2009; Dewitte et al., 2011; Brauer et al., 2007; Desrochers et al., 2010). Previous studies in the context of musculoskeletal pain have shown that habitual pain catastrophizing (PC) and fear-avoidance beliefs may contribute to the development and/or maintenance of pain symptoms (Linton et al., 2005; Severeijns et al., 2005; Leeuw et al., 2007). Thus, the habitual tendency to interpret pain signals in a catastrophic manner may be involved in the transition from acute to chronic pain symptoms (Susan et al., 2002; Edwards et al., 2009; Payne et al., 2005). In line with this, the Fear-Avoidance model of chronic pain indicates that catastrophic appraisal of experienced pain may promote hyper-vigilance and avoidance behaviour (Payne et al., 2005; Leeuw et al., 2007). Hyper-vigilance has been long attributed to cognitive misinterpretation and perceptual amplification of bodily sensations, symptoms, or cues (Watson and Pennebaker, 1989; Barsky and Klerman, 1983). Accordingly, catastrophic pain cognitions will operate in a way to intensify the pain-experience and thus trigger further avoidance behaviour, hence preventing the correction of such experiences (Crombez et al., 2005). As a consequence, people may enter a self-perpetuating downward spiral of increasing avoidance and anticipated pain.

In vaginismus, sexual pain or the anticipation of sexual pain may similarly give rise to catastrophic ideation (e.g., vaginal penetration will be painful) and vaginal penetration-related fear (ter Kuile et al., 2010; Reissing et al., 2004). In turn, the anticipation of catastrophic consequences may well contribute to hyper-vigilance towards painful sexual stimuli and stimuli that may predict painful experiences,

which may not only lower the threshold for negative physical sensations or touch, but may also contribute further to a negative appraisal of sexual cues, avoidance and/or withdrawal (Payne et al., 2005). Additionally, attempts of penetration that are met with a defensive pelvic floor muscle contraction or increased muscle tone may well add to the negative cognitions and confirm the negative expectations (ter Kuile et al., 2010; van der Velde et al., 2001; Reissing et al., 2004). Germane to this model there is evidence that people with sexual pain show heightened vigilance for coital pain and selective attention towards pain stimuli (Payne et al., 2005).

PC has been broadly conceived as an exaggerated negative "mental set" brought to bear during actual or anticipated pain experience, which contributes to more intense pain and emotional distress (Sullivan et al., 2001). Catastrophizing is described as a multidimensional trait in which activation, appraisal, attention, and coping are intertwined with the experience of noxious events (Sullivan et al., 2001). Several studies have shown that dispositional PC has predictive value for the intensity of experimentally induced pain response (Campbell et al., 2010; Goodin et al., 2009). This supports the view that dispositional catastrophizing can be considered as an enduring mode of responding that impact on various pain experiences. One would expect that women who show a habitual tendency to make such catastrophic interpretations of pain are likely to also apply a similar strategy to situational pain during (attempts of) penetration. Consistent with this idea that dispositional PC can be interpreted as a distal factor influencing more specific PC cognitions, previous research in the context of experimental pain typically reported correlations of around .45 between dispositional and pain specific situational catastrophizing (Goodin et al., 2009; Dixon et al., 2005). Thus if indeed dysfunctional pain cognitions play an important role in the aetiology and maintenance of sexual pain disorders, women with high PC would be especially at risk for developing this type of disorder. However, previous research has not found this straightforward association with heightened levels of generalized PC in women with vaginismus (Pukall et al., 2002; Reissing et al., 2004).

One explanation could be that the relationship between generalized PC and the development of sexual pain during vaginal penetration is moderated by individuals' habitual sensitivity for signals of punishment (such as pain) often defined as harm-avoidance (HA) (Pud et al., 2004; Torrubia and Tobena, 1984; Torrubia et al., 2001). HA is defined as *'a tendency to respond intensely to previously established signals of aversive stimuli and to learn to passively avoid punishment, novelty and frustrating non-reward (p. 32)'* (Pud et al., 2004). Thus the personality trait of HA is generally associated with hesitation, pessimism, being fearful and doubtful, and will logically support pain avoidance or escape behaviours, thereby preventing the disconfirmation of PC cognitions (Pud et al., 2004). Therefore, the influence of trait PC would be

especially prominent in generating persistent dysfunctional pain-related cognitions in women with relatively strong trait HA. If so, women with both high HA and high PC would be especially prone to develop vaginismus, and thus as a group, women with vaginismus would be characterized by a combination of heightened trait HA and PC.

In addition, trait HA might also be more directly relevant in the development and maintenance of vaginismus. The enhanced tendencies to avoid behaviours or stimuli that may inflict harm which characterizes HA, could well express itself in relatively strong defensive responses. In line with this, it has been shown that the harm-potentiated startle reflex is especially pronounced in high trait HA individuals. In the context of vaginismus this enhanced defensive responding, might also be reflected in relatively strong contraction of the pelvic floor muscles/vaginal flinching, which would logically interfere with sexual responding (van der Velde et al., 2001; Reissing et al., 2004). Following this, heightened trait HA per se may also contribute to the increased avoidance of vaginal penetration activities and defensive behaviours during gynecological examination, even independent of PC (Reissing et al., 2004).

To test the specificity of PC and HA in vaginismus, we added both a control group of women without sexual complaints, and a clinical control group of women suffering from dyspareunia, a sexual dysfunction from the same diagnostic category as vaginismus (i.e., sexual pain disorders). Thus the purpose of also including a dyspareunia group in this study was to add specificity in testing our hypothesis in a homogenous group of women with lifelong vaginismus. Whereas, the inability to have sexual intercourse is most central to vaginismus, for dyspareunia recurrent genital pain is the defining feature. Accordingly, dyspareunia is succinctly defined as *'recurrent or persistent pain during sexual activities with attempts or successful completion of penile-vaginal intercourse'* (Basson et al., 2004; Graziottin, 2008). For dyspareunia, its prevalence vary considerably with estimates as low as 0.4% up to 61% (Hayes et al., 2008). This high variation in this group reflects the inconsistent use of case definition and the heterogeneity of dyspareunia (Hayes et al., 2006, 2008). Provoked vestibulodynia (PVD), which is a common cause underlying dyspareunia, is estimated to affect 12% of premenopausal women in the general population (Goldstein and Pukall, 2009). Several studies showed that penetration-specific PC is an important component of dyspareunia and PVD (Pukall et al., 2002). Therefore enhanced general PC might also contribute to the development of dyspareunia (i.e., via influencing situational catastrophizing). However, just as for women with vaginismus, previous studies failed to find convincing evidence for heightened habitual PC in women with dyspareunia/PVD (Pukall et al., 2002; Payne et al., 2007). Nevertheless, perhaps also for this category of sexual pain disorders, especially the

combination of heightened HA and PC is most relevant rather than heightened PC per se. Germane to this speculation, previous research has provided preliminary evidence that PVD is indeed associated with heightened HA (Danielsson et al., 2001).

## 2.2 Methods

### 2.2.1 Participants

This study consisted of three groups; a lifelong vaginismus group ($n = 35$, mean age $= 28.4$; SD $= 5.8$) a dyspareunia group ($n = 33$, mean age $= 26.7$; SD $= 6.8$) and healthy women without sexual complaints ($n = 54$, mean age $= 26.5$; SD $= 6.7$). The two clinical groups were recruited at the University Medical Center Groningen. The healthy controls were recruited after the participants themselves contacted the research team following advertisement in the local media and on the university premises. A screening was conducted with the clinical group as well as with the healthy controls. The phone screening was especially important for the healthy controls to assure that we would only recruit women without sexual complaints. This screening was conducted over and above the other procedures. There were no significant differences in demographic data [$p > 0.10$] between the three groups in terms of age and education level. All the women were Caucasian and native Dutch. The participants had to be involved in a heterosexual relationship for a minimum of 6 months to be eligible for participation in the study.

An experienced gynecologist/sexologist examined both clinical groups (i.e., lifelong vaginismus and dyspareunia), using a gynecological-sexual clinical interview routinely used in our department as part of the assessment and diagnostic procedure (de Jong et al., 2009; Borg et al., 2010, 2011; Huijding et al., 2011; Spoelstra et al., 2011). The gynecological-sexual clinical interview included questions whether the women have tried and succeeded to insert a finger, penis or any other object (e.g., tampon) in her vagina. In addition, the diagnostic procedure included a physical examination following a thorough history of the participants, in accordance with recent comprehensive guidelines (van Lankveld et al., 2010). During the physical exam the women were always accompanied by their partner. To have a sense of control, preparation was done in advance by informing the woman that she has full autonomy to end the examination at any time, and was also reassured that a speculum was never used in the diagnostic procedure. As a first step the woman was given a mirror and the gynecologist guided her through an anatomical description of her genital area using a moistened cotton swap to identify all structures. Once encouraged to feel as relaxed as possible, the woman was asked to press against the gynecologist finger - placed on the hymen. At this point, in women with lifelong

vaginismus the gynecological-sexual exam was usually terminated due to overactivity of the pelvic floor and/or involuntary guarding behaviour. In this study, the diagnosis of lifelong vaginismus and of dyspareunia was made based on formulated criteria by an international committee of experts in the field (Basson et al., 2004).

Inclusion criteria for the (acquired/lifelong) dyspareunia group were persistent or recurrent pain in at least 50% of attempted or complete vaginal penetrations and/or penile vaginal intercourse, with duration of 6 months or more. In the current study, the dyspareunia group was found to be composed of 60.6% of women with PVD. In order to have a highly homogenous group no women included in the lifelong vaginismus group had a diagnosis or comorbidity of PVD. For the purpose of this study inclusion in the lifelong vaginismus group was only possible when in the context of being assisted to relax, attempts to insert a finger into the vagina elicited an involuntary guarding reaction and a report of state fear at the attempt (or even the thought) of vaginal penetration during the gynecological-sexual exam (Klaassen and Ter Kuile, 2009). For the inclusion this guarding-avoidance behaviour had to be present also outside the clinic on attempts of vaginal penetration, together with the history of no previous vaginal penetration (finger, penis or any other object) (Basson et al., 2004; Klaassen and Ter Kuile, 2009). The total sample diagnosed with lifelong vaginismus and dyspareunia were recruited in the period of 2005 to 2011.

### 2.2.2 Measures

**Harm avoidance of the tridimensional questionnaire (HA)**

The Harm Avoidance scale of the Cloninger's Tridimensional Personality Questionnaire (HA) consists of 34 items with statements about one's feelings and beliefs (Cloninger, 1987; Cloninger et al., 1991). Participants who score high on Harm Avoidance (HA) are described as individuals who worry a lot and perceive the future as more pessimistic, and who are usually anxious, doubtful, avoidant, shy, and easy to exhaust (Ettelt et al., 2008). The translated version of HA was used for this study. The psychometric properties of the Dutch HA have not been published but it has been used in several studies with Dutch samples, with generally good psychometric properties (Franken and Muris, 2006). In the current study, the reliability of the HA scale in terms of internal consistency was excellent with a Cronbach's $\alpha$ of $.85$. Participants had to respond with either *True* or *False* to each of the statements.

**Pain catastrophizing scale (PCS)**

The Pain Catastrophizing Scale is a 13-item self-report measure which consists of statements, describing thoughts and feelings that people experience when they are in pain (Sullivan et al., 1995). Thus participants who score high on PCS are described as individuals who have a tendency to magnify the pain sensation, show difficulty diverting attention away from pain and express an inability to cope with the pain (Sullivan et al., 1995). The Dutch translated PCS was used for this study (Crombez and Vlaeyen, 1996). This version of the PCS has shown to be valid and reliable (Van Damme et al., 2002). The current study showed a Cronbach's alpha of .90. The participants were asked to read and indicate to what degree a given statement applies to them when they are in pain (with no specific context of pain) on a five-point scale from 0 (not at all) to 4 (All the time).

### 2.2.3 Procedure

This study is part of a broader ongoing research into the cognitive-motivational processes involved in sexual pain disorders. Part of the participants sample ($n = 80$) completed the questionnaires in the research lab; the other part of the sample ($n = 41$) filled in the questionnaires at their own house. Data from the 2nd group were added from a sequential study using functional magnetic resonance imaging. Recruitment did not influence the results in any direction in terms of outcome measures. Approval was obtained from the Medical Ethical Committee of the University Medical Center of Groningen, and all the work was carried out according to its standard. A modest reimbursement was given to each participant after completion of the study.

### 2.2.4 Statistical analysis and data reduction

To test the potential difference in Pain Catastrophizing (PCS) and Harm Avoidance (HA) across the 3 groups we carried out a one-way Analysis of Variance [ANOVA] with each dependent variables (i.e., HA and PCS total score), and Group as the independent variable. Finally, in order to further explore to what extend PC and HA and/or their interaction [PC$\times$HA] are independently related to vaginismus and/or dyspareunia, a series of logistic regression analyses with dummy coded group as the dependent, and HA, PC and [PC$\times$HA] as the predictors were done. Variables were centered before entering the analyses. Three comparisons were conducted in order to explore the unique predictability: i) vaginismus vs. group free of sexual complaints; ii) vaginismus vs. dyspareunia and iii) dyspareunia vs. group free of sexual complaints.

Table 2.1: Pain catastrophizing and harm avoidance

| Group | PC Total | HA Total |
|---|---|---|
| Controls | 17.4 (9.1):3-43 | 13.3 (6.2):2-33 |
| Vaginismus | 22.0 (9.3):1-39 | 16.5 (5.2):6-25 |
| Dyspareunia | 15.3 (7.3):5-34 | 14.6 (5.7):3-27 |

M(SD): Range

## 2.3 Results

### 2.3.1 Pain catastrophizing (PC)

The means, standard deviations and the range are presented in Table 2.1. There was a medium sized main effect of group $[F(2, 119) = 4.9, p < .01, \eta^2 = .08]$. As can be seen in Table 2.1, the vaginismus group ranked highest in PC cognitions, dyspareunia showed the lowest scores, and the women free of sexual complaints ranked in between the two clinical groups. Post-hoc comparison using Least Square Difference (LSD) demonstrated that women in the vaginismus group reported significantly more PC cognitions than women with dyspareunia [M$-$diff $= 6.3$, SD $= 2.1, p < .01$ (95% CI: 2.1 to 10.5)] and women free of sexual complaints [M$-$diff $= 4.6$, SD $= 1.9, p < .01$ (95% CI: .8 to 8.30)]. There was no significant difference between the dyspareunia group and the group free of sexual complaints [M$-$diff $= -1.7$, SD $= 1.9, p > .05$, (95% CI: $-5.6$ to 2.1)].

### 2.3.2 Harm avoidance (HA)

A one-way Analysis of Variance [ANOVA] with HA total score as the dependent variables, and Group as the independent variable showed a significant medium sized difference between groups $[F(2, 119) = 3.23, p < .05, \eta^2 = .05]$. Subsequent paired comparisons (Least Square Difference; LSD) demonstrated that women in the vaginismus group showed a significantly higher score than women free of sexual complaints [M$-$diff $= 3.21$, SD $= 1.3, p < .01$ (95% CI:.71 to 5.7)], whereas the difference between the vaginismus and dyspareunia group did not reach significance [M$-$diff $= 1.9$, SD $= 1.4$ (95% CI: $-.9$ to 4.7)]. Neither did the dyspareunia group differ significantly from the group free of sexual complaints [M$-$diff $= 1.33$, SD $= 1.3, p > .05$].

Table 2.2: Variables predicting membership in either the vaginismus or the control group

| | $\beta$ | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| PC | .22 | .080 | 7.62 | 1 | .006 | 1.25 |
| HA | .34 | .121 | 7.89 | 1 | .005 | 1.40 |
| PCxHA | -.01 | .000 | 5.53 | 1 | .019 | .99 |
| Constant | -6.28 | 1.89 | 11.00 | 1 | .001 | .00 |

Predictors entered in the regression PC. HA. PCxHA; Exp(B) = odd ratio

### 2.3.3 Harm avoidance and pain catastrophizing

The full first model containing all the predictors was statistically significant $\chi^2(N = 89) = 15.93, p < .001$, indicating that the model was able to distinguish between participants belonging to the vaginismus group and those in the group free of sexual complaints. The model as a whole explained between 16.4% (Cox and Snell R square) and 22.2% (Nagelkerke R Squared) of the variance in-group membership, and correctly classified 64% of the participants. On inspecting further the independent variables, each one of the three made a unique statistically significant contribution to the model (Table 2.2; HA, PC and PC $\times$ HA)

The presence of vaginismus was associated with high PC and high HA, with the highest predictive validity for the presence of vaginismus when high PC and high HA were combined. The significant interaction term indicates that high PC is especially relevant for women with relatively low HA scores. In other words, the stronger the HA the less additional predictive validity it has for PC.

The 2nd full model containing all the predictors was statistically significant $\chi^2(n = 68) = 13.37, p < .004$, indicating that the model was able to distinguish between participants belonging to the vaginismus group and those to the dyspareunia group. The model as a whole explained between 17.8% (Cox and Snell R square) and 23.8% (Nagelkerke R Squared) of the variance in group membership. Further inspecting the independent variables in more detail revealed that only PC made a unique statistically significant contribution at $p < .05$ with an odds ratio of 1.4. Although, there was a trend suggesting that high HA has additional predictive validity for classifying women as belonging to the vaginismus group this contribution did not reach the conventional level of statistical significance $(p = .058)$. Neither did the contribution of the interaction term reach significance $(p = .074)$.

The last model in this series of logistic regressions compared dyspareunia with the women free of sexual complaints. The full model containing all the predictors did not reach statistical significance $\chi^2(n = 62) = 3.1, p < .38$, indicating that the model was not able to distinguish between participants, belonging to the dyspareunia group and those women free of sexual complaints.

Table 2.3: Variables predicting membership in either the vaginismus or the dyspareunia group

| | $\beta$ | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| PC | .32 | .14 | 5.28 | 1 | .020 | 1.37 |
| HA | .30 | .16 | 3.60 | 1 | .058 | 1.35 |
| PCxHA | -.01 | .01 | 3.19 | 1 | .070 | .98 |
| Constant | -5.99 | 2.51 | 5.69 | 1 | .020 | .00 |

Predictors entered in the regression PC, HA, PCxHA; Exp(B) = odd ratio

## 2.4 Discussion

The core findings can be summarized as follows: i) specifically women inflicted with lifelong vaginismus showed heightened levels of catastrophic pain cognitions (PC) as well as enhanced personality trait of harm avoidance (HA) compared to women free of sexual complaints. (ii) Although, both PC and also HA showed to be associated with vaginismus, results indicated that PC was especially relevant for women with relatively low harm avoidance. (iii) Women with dyspareunia showed similar levels of PC and HA as the women free of sexual complaints. (iv) The difference between dyspareunia and vaginismus was pronounced for PC (but not for HA).

In apparent conflict with previous research that failed to find a generally heightened PC in women suffering from vaginismus, the present study found a significant difference between the general PC scores of women with vaginismus vs. both women free of sexual complaints and women suffering from dyspareunia (Reissing et al., 2004). The PC scores of the women with vaginismus were in the same range as those previously found for people suffering from chronic low back pain; thereby supporting the view that enhanced PC may set women at risk for developing vaginismus (Van Damme et al., 2002).

One explanation for the fact that in contrast to previous research the present study did find heightened PCS scores in women with vaginismus might be that in this study we used a very rigid categorization, in that only women with lifelong vaginismus and no underlying PVD were assigned to the vaginismus group. The diagnosis of lifelong vaginismus versus acquired vaginismus may impact the results; in that in lifelong vaginismus trait PC may prevent successful penetration, whereas in acquired vaginismus penetration was possible (at some point) and only after a specific (painful/noxious) penetration-related event it became impossible. Thus in secondary vaginismus specific experiences rather than pre-morbid traits may be most critical. Perhaps, then, differences in the diagnostic procedure (including lifelong vs. a broader spectrum of women with vaginismus) and/or severity of the cases may help explain why in the mentioned previous study there was neither

a significant difference between the vaginismus and the healthy control group, nor between women assigned to the vaginismus and those assigned to the dyspareunia group (Reissing et al., 2004).

The present finding that women with vaginismus show heightened PC is consistent with the view that catastrophic appraisal of anticipated pain may promote hyper-vigilance to pain, with further distraction and avoidance behaviour which keeps these women in the vicious cycle of vaginismus (Payne et al., 2005; Reissing, 2009). Women with vaginismus also showed heightened HA, that was found to independently contribute to group membership (in vaginismus vs. women free of sexual complaints). Moreover, there was a similar trend suggesting that HA was also higher in the vaginismus group than in the dyspareunia group. This is in line with previous behavioural evidence showing that women with vaginismus displayed stronger defensive reactions during gynecological examinations than women with dyspareunia (Reissing et al., 2004). Heightened HA may play a critical role in motivating avoidance behaviours and thus in preventing the occurrence of correcting these negative experiences (Sullivan et al., 2001; Rief et al., 2012; Vlaeyen et al., 1995; Lefebvre and Keefe, 2002). In the same vein, HA could express itself as a general tendency to avoid behaviours/stimuli that may inflict harm, which in turn could give rise to relatively strong defensive responses (e.g., pelvic floor muscles contraction) (Reissing et al., 2004; van der Velde et al., 2001). As a consequence PC and HA may jointly contribute to elicit further (harm) avoidance behaviour, triggering this downward vicious spiral which may contribute to the inability to have sexual intercourse.

Based on earlier research that failed to find significantly heightened general PC in women suffering from vaginismus, we hypothesized that the relationship between PC and vaginismus might perhaps only be evident in high HA individuals (Reissing et al., 2004). Although, indeed, the combined presence of high PC and high HA was most predictive for the presence of vaginismus; PC also showed to be relevant for women who were relatively low on HA. We even found that the additional predictive validity of PC was especially pronounced for low HA women. However, this probably reflects a ceiling effect. That is, once HA is high to a specific extent, it exceeds and overshadows the importance of the other main effect (i.e., PC) and vice versa. Our findings are most consistent with a (summative) main effect model, and suggest that women with both high PC as well as high HA might be especially at risk for developing and maintain the vicious cycle of vaginismus.

The present study also indicates that there are differences between dyspareunia and vaginismus regarding their general PC and HA cognitions. The current findings suggest that in contrast to vaginismus, heightened general PC and/or high HA are not critically involved in our sample of women with dyspareunia. The ab-

sence of heightened trait PC in dyspareunia is consistent with previous research that also failed to find evidence for generally heightened PC. Yet, these earlier studies did find evidence for sexual pain specific PC in dyspareunia and convincingly showed that women with PVD (which makes-up 60.6% of our dyspareunia group) do report more penetration-specific catastrophizing thoughts (Pukall et al., 2002; van Lankveld et al., 2010). Apparently in dyspareunia/PVD, PC is very specific and elicited by particular painful experiences related to penetration, rather than being the result of a more distal generalized tendency to catastrophize about potential painful experiences which seems to be playing a role in vaginismus (Goodin et al., 2009; Dixon et al., 2005). It would be interesting for future research to more directly test whether heightened general PC is specifically involved in vaginismus, whereas the more penetration-specific cognitions are reciprocally involved in both dyspareunia and vaginismus.

The absence of systematically heightened HA in our group of women with dyspareunia seems in line with the observation that women with dyspareunia often report to continue having intercourse though with pain. However, the absence of heightened HA in the present study is in apparent contrast with previous findings showing that women with dyspareunia report higher trait HA than healthy controls (Danielsson et al., 2001; Granot and Lavee, 2005; Granot, 2005). This incongruence could perhaps (at least partly) be explained by the heterogeneity within this diagnostic category. In addition, it might be due to insufficient power of the present study to reliably detect small effects. Clearly, then, future research is required to arrive at more final conclusions regarding the relevance of HA in dyspareunia.

### 2.4.1 Clinical implications

The present findings of heightened general PC and HA particularly in vaginismus, elicits consideration for treatment interventions. PC denotes a series of pain cognitions such as difficulty focusing attention away from pain, perceiving pain as more intense, and feeling helpless to control pain. Hence the previously mentioned difficulties associated with pain during vaginal penetration, become even more disruptive. These findings and previous literature illustrate that women with vaginismus might benefit by learning to identify, and replace the maladaptive pain related thoughts (Donaldson and Meana, 2011).

For instance challenging women's dysfunctional beliefs and pain related catastrophic thinking could also be tracked by using the responses of a tool similar to PCS to discuss the clients' general catastrophic thought processes. Thus, it is beneficial when women understand that despite that a small percentage of the catastrophic thoughts might contain some truth, certain aspects of these catastrophic cognitions

might not be completely realistic. Choosing alternative thoughts might also aid to understand how these negative PC cognitions can elicit automatic associations that maintain further the avoidance behaviour. This is especially relevant when the person is also characterized by HA and therefore, avoids experiences that can disconfirm these beliefs. These findings emphasize the importance of targeting catastrophic thinking and possibly help the individual to engage (e.g., via exposure) in experiences to reframe such beliefs (de Jong et al., 2005; Turk and Rudy, 1988). Moreover, the success of exposure treatment in women with vaginismus, is entirely in line with the idea that symptoms (at a minimum) are maintained by avoidance, which may be fuelled by PC and/or HA (ter Kuile et al., 2007; Watts and Nettle, 2010). Additionally, evidence from previous studies show that HA correlates with strong pain response, thus it would be particularly beneficial for relatively high HA individuals to replace the downward spiral discussed earlier, with a more functional approach (Torrubia and Tobena, 1984; Watts and Nettle, 2010).

### 2.4.2 Limitations and research directions

The present study relied on subjective retrospective questionnaires, which can be influenced by self-presentational concerns. However, since pain and pain cognitions are intrinsically subjective there is no easy way to circumvent this potential draw back. Another limitation is that the subjective fear reported by women during the gynecological-sexual exam was unstandardized. It would be helpful for future studies to have such measures more standardized. In addition, the cross-correlational nature of this study does not allow any firm conclusion regarding the direction of the relationships. Prognostic studies are required to test whether indeed enhanced PC/HA set people at risk for developing and/or promote the persistence of pain with vaginal penetration or can better be interpreted as a consequence of this condition/specific symptom. Furthermore, it should be acknowledged that we did not measure pain/harm cognitions related to concrete sexual activities or sexual context. It would be interesting for future research to replicate whether a similar pattern would be evident if the cognitions are confined to pain during vaginal penetration (Reissing et al., 2004; Klaassen and Ter Kuile, 2009). In addition, previous research with the PCS has shown that PC consists of three largely independent components: rumination, magnification, and helplessness (Payne et al., 2005). It would be interesting to explore further whether the different components of PC would also be differentially related to the processes that are implied by the fear-avoidance model of vaginismus. One might expect that the subscale of PCS-Magnification would be most closely related to the perceptual amplification of pain cues and thus heightened hyper-vigilance; whilst rumination might be involved more in distraction from

sexual cues. Thus both these subscales might also be related to HA and contribute to the downward fear-avoidance spiral. The helplessness component might be more related to (preventing) attempts of having intercourse, thereby contributing to avoidance of particular sexual behaviours that might refute their dysfunctional (fearful) cognitions. Additionally, it might be beneficial to know the motivational goals for women with pain during intercourse (dyspareunia), to still approach (and have) sexual intercourse. As a final limitation, we have to be cautious in generalizing these results as our sample was strictly consisting of highly homogenous women with lifelong vaginismus, who were in a relationship, and showed only limited or no variation in their cultural background.

### 2.4.3 Conclusions

This study is a first attempt to focus on general pain cognitions together with personality traits of harm avoidance in women with lifelong vaginismus and our findings indeed show that, women suffering from vaginismus are characterized by traits of harm avoidance and by habitual pain catastrophizing cognitions. The application of this research may aid in the refinement of the present conceptualization of vaginismus and it sheds light on personality traits that seems to be implicated in the aetiology and/or persistence of this disorder. This is not only of theoretical relevance, but may also provide leads to improve further the currently available treatment options.

# Chapter 3

# Relationship with general and sex related moral standards

**Abstract**

*Relatively strong adherence to conservative values and/or relatively strict sex-related moral standards logically restricts the sexual repertoire and will lower the threshold for experiencing negative emotions in a sexual context. In turn, this may generate withdrawal and avoidance behaviour, which is at the nucleus of vaginismus. Our main aim was to examine whether indeed strong adherence to conservative morals and/or strict sexual standards may be involved in vaginismus. In this study as outcome measures we used the Schwartz Value Survey (SVS) to investigate the individual's value pattern and the Sexual Disgust Questionnaire (SDQ) to index the willingness to perform certain sexual activities as an indirect measure of sex-related moral standards. The SVS and SDQ were completed by three groups: women diagnosed with vaginismus ($n = 24$), a group of women diagnosed with dyspareunia ($n = 24$), and a healthy control group of women without sexual complaints ($n = 32$). Specifically, the vaginismus group showed relatively low scores on liberal values together with comparatively high scores on conservative values. Additionally, the vaginismus group was more restricted in their readiness to perform particular sex-related behaviours than the control group. The dyspareunia group, on both the SVS and the SDQ, placed between the vaginismus and the control group, but not significantly different than either of the groups. The findings are consistent with the view that low liberal and high conservative values, along with restricted sexual standards, are involved in the development and/or maintenance of vaginismus.*

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## 3.1 Introduction

Vaginismus is defined as *'persistent or recurrent difficulties of the woman to allow vaginal entry of the penis, a finger, and/or any object, despite the woman's expressed wish to do so. There is variable (phobic) avoidance, involuntary pelvic muscle contraction and anticipation/fear/experience of pain. Structural or other physical abnormalities must be ruled out and addressed'* (Basson et al., 2004). It occurs in approximately 0.5 to 1% of women of childbearing age, though accurate estimates are lacking (Basson et al., 2004; Graziottin, 2008). Vaginistic complaints often have a chronic course and may result in considerable emotional distress.

The existing literature does not point to a definite aetiology of vaginismus, but several factors have been implicated as part of the cause of vaginismus, including neurochemical, neurophysiological, and psychological components (Reissing, 2009). Current psychological theories of sexual dysfunctions focus on the role of negative emotional reactions towards sexual stimuli (van der Velde et al., 2001; de Jong et al., 2009). One pathway that may help to explain negative emotional responding towards particular sexual behaviours is to explore the presence or level of adherence to conservative moral values. There is evidence indicating that women with high adherence or devotion to conservative values also show less tolerance to a range of sexual behaviours (Yasan and Akdeniz, 2009). Reduced tolerance towards various sexual expressions/behaviours logically restricts the sexual repertoire and will lower the threshold for experiencing negative emotions in a sexual context (Haidt and Hersh, 2001). In turn, this may generate withdrawal and avoidance behaviour thereby disrupting sexual arousal.

To tap into the individual's values, the Schwartz Value Survey (SVS) is a useful instrument (Schwartz and Bilsky, 1987). The SVS differentiates between 'conservative values' and 'liberal values' (Rempel and Baumgartner, 2003). People with less liberal principles are assumed to attach little importance to indulgence, sensuality, and emotional gratification,, whereas strong adherence to liberal values are associated with recognizing sex as an enjoyable experience and an emotional release (Basson and Weijmar Schultz, 2007). High scores on conservative values, that is the presence of more conservative moral principles, including limiting actions and impulses or general difficulty with transgression (wrongdoing), may play a negative role in sexual behaviour. If this is radiated to moral values specifically towards sex, sexual experiences might be very restricted. Moreover, if these values have become ingrained in the woman's system; in her core beliefs and perspective from an early age (e.g., through education, cultural rules, religion etc.) they may automatically elicit defensive associations and avoidance behaviour in sexual confrontations (Cowden and Bradshaw, 2007; Silverstein, 1989). From this perspective, it can be hy-

pothesized that women with lower scores on the 'liberal' and higher scores on the 'conservative' subscales would thus, be more inclined to develop sexual dysfunctions, or at the very least difficulties with sexual expression and/or responding.

Intertwined with the more general pattern of conservative versus liberal norms and values, certain (negative) sexual beliefs can also have a more direct effect on the expression and responsivity to sexual cues and stimuli which may increase the risk for sexual dysfunctions (Nobre and Pinto-Gouveia, 2006; Basson, 1996; Ward and Ogden, 1994). This entanglement of conservative values and strict sexual beliefs may well set people at risk for developing sexual problems associated with disrupted arousal and/or sexual absorption (de Jong et al., 2009). Consistent with this view, research has shown that women with sexual dysfunctions were indeed more conservative in their sexual beliefs (e.g., 'Masturbation is wrong and pointless', 'Achieving an orgasm is acceptable for men but not women', and 'Anal sex is a perverted activity') to the level that they tend to frame sex as a sin (Nobre and Pinto-Gouveia, 2006, 2008). In the same vein, conservative religiosity was found to be a predictor of negative emotions after masturbation/self-stimulation (Yasan and Akdeniz, 2009). Additionally, women with vaginismus report less self-stimulation, and show a higher prevalence of problems with sexual desire and arousal (Weijmar Schultz et al., 2005; Reissing et al., 2004).

Consistent with this conceptualization, women with vaginismus showed a general enhanced disgust propensity and heightened disgust in response to sexual stimuli (de Jong et al., 2009; Borg et al., 2010). Recent evidence demonstrates that the prospect of transgressing socio-moral rules may give rise to intense feelings of disgust, and has been shown to elicit the same levator labii responsivity and behavioural responses as seen in core and disease vector disgust (Chapman et al., 2009; Zhong and Liljenquist, 2006). Perhaps, then, the perceived 'immorality' of particular sexual behaviours and/or the perceived moral impurity of specific sexual stimuli contribute to the defensive reflexes of the pelvic floor muscles that characterize vaginismus.

The experience of disgust itself may further shape and strengthen people's moral values (Schnall et al., 2008). Accordingly, feelings of disgust towards sexual stimuli may further enhance the influence of already present sexually restrictive moral standards and negative (sex) beliefs, thereby lowering the threshold for eliciting defensive reflexes. In view of that, the presence of high adherence to moral standards and/or negative sexual beliefs may help (at least partially) to explain the core symptoms of vaginismus.

The present study was designed to examine whether higher adherence to conservative and sexual standards may indeed be involved in vaginismus. More specifically, we tested whether women with vaginismus demonstrate stronger adherence

to conservative values together with less adherence to liberal values than women without sexual complaints, and whether these alleged conservative standards are also evident in the domain of sexual behaviours.

As high devotion/adherence to moral values and (negative) sex beliefs may interfere with healthy sexual arousal and absorption in general, a similar pattern of values may be also evident in other sexual dysfunctions/conditions. To explore this possibility we also included a second clinical group from the same diagnostic category of sexual pain disorders (i.e., dyspareunia). Whereas, the inability to have sexual intercourse (due to/without pain) is most central to vaginismus, for dyspareunia recurrent genital pain (or fear of pain) is the defining feature.

## 3.2 Method

### 3.2.1 Participants and recruitment

This study consisted of three groups; a primary vaginismus group ($n = 24$, mean age $= 30.1$; SD $= 5.6$) a dyspareunia group ($n = 24$, mean age $= 28.8$; SD $= 6.9$) and healthy women without sexual complaints ($n = 32$, mean age $= 29.5$; SD $= 7.2$). The two clinical groups were recruited at the University Medical Centre Groningen. The healthy controls were recruited after the subjects themselves contacted the research team following advertisements in the local media and in the university premises. A screening was conducted with the healthy controls, in order to include only females that were in a heterosexual relationship and with no sexual complaints. In the final selection, care was taken to match the healthy controls to the clinical groups in terms of age and educational level. There were no significant differences in age $[p = .80]$ or educational level $[p = .9]$ between the three groups. All the women were Caucasian and native Dutch. The participants had to be involved in a heterosexual relationship for a minimum of 6 months to be eligible for participation in the study.

An experienced gyneacologist and sexologist examined both clinical groups (i.e., primary vaginismus and dyspareunia), using a validated semi-structured sexual interview. In addition, the diagnostic procedure included a physical examination, in accordance with recent comprehensive guidelines (van Lankveld et al., 2010). In this study, the diagnosis of primary vaginismus and of dyspareunia was made based on formulated criteria by an international committee consisting of experts in the field (Basson et al., 2004).

Inclusion criteria for the dyspareunia group were persistent or recurrent pain in at least 50% of attempted or complete vaginal penetrations and/or penile vaginal intercourse, with duration of 6 months or more. The dyspareunia control group consists of women with: PVD (54.2%), Psychological causes/expectations (16.7%),

Lichen sclerosus (4.2%), Post traumatic sex experience of being touched or involuntarily sexually approached (8.3%), Recurrent candida vaginitis (8.3%), Endometriosis (4.2%).

### 3.2.2 Measures

#### Golombok rust inventory of sexual satisfaction (GRISS)

To measure the most common psychosexual complaints in the 3 groups of women, the authorized Dutch version of the GRISS questionnaire was used (Lankveld and Kuile, 1999; ter Kuile et al., 1999). This self-report questionnaire consists of 28 items and is often used as a screening tool, as well as a measure of therapy progress. The GRISS covers the most frequently occurring sexual dysfunctions of heterosexual persons with a steady partner, while the female version of the GRISS covers 7 frequently occurring sexual complaints. The GRISS provides a total score of the person's satisfaction with sexual functioning within the relationship, rated on a five-point response scale ranging from (1) 'never' to (5) 'always'. Thus, the higher the score, the greater the sexual satisfaction experienced by the individual. It has been validated within the Dutch population and its psychometric properties were found to be satisfactory (Lankveld and Kuile, 1999; ter Kuile et al., 1999).

#### Schwartz value survey (SVS)

To measure the values and the potential implication of socio-moral disgust, we used SVS, a self-report questionnaire (Schwartz, 1992; Rempel and Baumgartner, 2003). This SVS is composed of 3 parts: two value lists and one section with demographical questions. The two value lists contain overall 57 items in terms of value description. An exemplar from SVS of a typical conservative value is 'conformity'; whereas 'stimulation' is given as a distinctive liberal value. The task is to rate how important each value is for the respondent as a guiding principle in life, on a scale of (0) 'not important at all' to (6) 'very important'. Additionally, outstanding values, which either are opposed to the participants' principles or of superior importance, can be rated with (-1) or (7) respectively. These 57 items represent 10 value types at an individual level. Each value was accompanied by a brief explanation for further clarification (Schwartz and Bilsky, 1987).

#### Sexual disgust questionnaire (SDQ)

To further investigate whether this concept of restricted values reflects a more generalized phenomenon and/or one that is also specifically evident in the sexual do-

main, we administered the SDQ (de Jong et al., 2009; Genten, 2005). The latter was added in order to shed light on the relationship between specific sexual attitudes/beliefs (i.e., willingness to perform certain actions as indexed by specific questions in the SDQ) and sexual dysfunctions. The SDQ is a tool designed to measure specifically sex-related disgust sensitivity and contamination (de Jong et al., 2009). For the core purpose of this study, we only utilized questions that particularly referred to moral issues. The questionnaire is composed of 24 scenario descriptions (i.e., hypothetical situations) on which the participants had to identify the extent they would be willing to participate in, on a scale from (0) 'definitely not willing' to (8) 'definitely willing'. Specifically, in SDQ the willingness to perform a certain action that implied physical contact with certain sexual stimuli is demanded (de Jong et al., 2009). The SDQ consisted of items such as 'touching and examining a vibrator' (see Appendix 3.B). The SDQ has satisfactory reliability in terms of internal consistency and test-retest reliability (Genten, 2005).

### 3.2.3 Procedure

The respondents were invited to complete the questionnaires at the psychology faculty laboratory of the University of Groningen.

For the SVS, each female participant was asked to first read both value lists and anchor her responses by rating the value most prominent in guiding her life (i.e. 7), followed by the value that is most opposed to her value system (i.e. -1). If no such value merits (-1) in the participant's opinion, she was instructed to give the digit of least importance (i.e. 0/1). After anchoring the end-points, the participant could indicate with a figure the rest of the values in accordance with the degree of importance. For the SDQ, participants were asked to carefully read the list of scenarios presented to them and indicate their willingness to involve themselves in these scenarios. Following both questionnaires, participants were asked to fill in the GRISS. The procedure was thoroughly explained to the participants before they were left in their own privacy. Questionnaires were given an anonymous subject number before being given to the participants and when fully completed, they had to be deposited in a closed box for complete anonymity.

This study is part of a broader ongoing research investigating the cognitive-motivational processes involved in female sexual pain disorders. Approval was obtained from the Medical Ethical Committee of the University Medical Center of Groningen, and all the work was carried out according to its standard.

### 3.2.4 Data reduction

All items on the SVS belong to ten different subscales that are categorized according to stipulated guidelines (Schwartz and Boehnke, 2004). Each subscale is the average of the corresponding items, which then generate the new variable for each of the 10 values. The variable 'Conservative' was indexed by the mean of the subscales Traditionalism, Conformity, and Security. This index reflects inflexibility to change, reduced likeliness of violating established norms and values, along with more (value) weight given to tradition and humanity.

Our version of the SDQ only comprises the questions that refer directly to moral issues and sex-related attitudes (see Appendix 3.B). After extracting an average score for each individual item, an average score for all items was provided. Higher scores indicate higher willingness to indulge in the mentioned scenarios. The mean score on all 28 items of the GRISS was produced to provide the total score of sexual satisfaction for each individual.

## 3.3 Results

### 3.3.1 Golombok rust inventory of sexual satisfaction (GRISS): sexual satisfaction

To measure the degree of sexual satisfaction and complaints, we analysed the mean of the total GRISS score, across the 3 groups. We conducted a one-way Analysis of Variance [ANOVA] with GRISS score as the dependent variable and Group as the independent variable. The higher the mean score on GRISS, the more this reflects satisfaction and thus fewer sexual complaints.

In line with our expectations the mean score for the vaginismus group was the lowest [M $= 3.25$, SD $= .57$], the highest for the healthy control group [M $= 3.97$, SD $= .44$], and the dyspareunia group in between the other two groups [M $= 3.49$, SD $= .44$]. In line with our expectations, the GRISS scores differed significantly between groups [$F(2, 77) = 15.37, p < .001, \eta^2 = .40$]. Post hoc comparisons Least Square Difference (LSD) demonstrated that women in the control condition reported significantly fewer sexual problems than women with vaginismus [M$-$diff $= .71$, SD $= .13, p < .001$ ($95\%$ CI: $.45$ to $.98$)]. The dyspareunia group also differed significantly from the control group [M $-$ diff $= .48$, SD $= .13, p < .001$ ($95\%$ CI: $.21$ to $.75$)], but women with dyspareunia did not differ significantly from the women with vaginismus, though there was a trend towards less satisfaction in the vaginismus group [ M $-$ diff $= .24$, SD $= .14$ ($95\%$ CI: $-.05$ to $.52$)]. It should be acknowledged that the GRISS might be biased towards penetrative sexual activity and participants

may interpret 'lovemaking' and 'sex' as intercourse and endorse with lower values either because they do not enjoy the activity or because they do not engage in the activity. Thus the relatively low scores of the women with vaginismus or dyspareunia should be interpreted with care.

### 3.3.2 Schwartz value survey (SVS): conservative & liberal

A 2 value (liberal, conservative) $\times$ 3 group (dyspareunia, vaginismus, control) mixed ANOVA with value as the within subject factor and group as the between subject factor, showed a significant interaction, of group $\times$ value $[F(2, 77) = 3.49, p < .05, \eta^2 = .04]$. The groups indeed showed the predicted differential pattern in their values: Women with vaginismus had relatively low scores on liberal values together with comparatively high scores on conservative values. Mean scores on the (composite) conservative scale being [M $= 3.8$, SD $= .9$], [M $= 3.6$, SD $= .9$], and [M $= 3.5$, SD $= 1.1$] for the vaginismus, dyspareunia and healthy control group, respectively. Mean scores on the (composite) liberal scale being [M $= 4.2$, SD $= .8$], [M $= 4.4$, SD $= .9$], and [M $= 4.7$, SD $= .9$] for the vaginismus, dyspareunia and healthy control group, respectively.

Subsequent analyses indicated that, as expected the pattern of values differed significantly between the vaginismus and the control group, with a large effect size $[F(1, 54) = 6.35,\ p < .01$, Wilks' $\lambda = .89,\ \eta^2 = .10]$. The pattern of values did not differ significantly between the dyspareunia and the control group $[F(1, 54) = 1.55,\ p > .05$, Wilks' $\lambda = .97,\ \eta^2 = .02)]$, or between the dyspareunia and the vaginismus group $[F(1, 46) = 1.94,\ p > .05$, Wilks' $\lambda = .95,\ \eta^2 = .04]$.

### 3.3.3 Sexual disgust questionnaire (SDQ): sexual willingness

The vaginismus group showed the lowest mean score on the items in SDQ [M $= 4.25$, SD $= 1.63$] thus, expressing relatively less willingness to participate in the sexual scenarios presented to them. The healthy controls had the highest mean score [M $= 5.58$, SD $= 1.24$], with the dyspareunia in between the other two groups [M $= 4.92$, SD $= 1.47$]. A one-way ANOVA was conducted to test whether any of the mean scores on the specific questions of the SDQ differed between the groups (see Appendix 3.B); Mean score on the SDQ served as the dependent variable with group as the independent variable. A main effect of group was found for SDQ $[F(2, 77) = 5.82,\ p < .004,\ \eta^2 = .15]$. Post hoc (LSD) comparisons showed that the vaginismus group differed significantly from the controls [M $-$ diff $= 1.33$, SD $= .38,\ p < .001$ (95% CI: .55 to 2.10)] the dyspareunia group also showed a trend towards less willingness to perform certain sexual acts, in comparison to the control

Table 3.1: Summary of regression results with SDQ as the dependent variable

| | B | S.E. | $\beta$ | $t$ | Sig. (p) |
|---|---|---|---|---|---|
| Conservative | -.83* | .17 | -.55 | -4.85 | <.001 |
| Liberal | .67* | .16 | .43 | 4.11 | <.001 |
| Conservative×Liberal | .05 | .13 | -.04 | -.33 | .74 |

$R^2 = .31$, *illustrates the unique contribution to the prediction of SDQ

group, but the latter did not reach significance [M $-$ diff $= .66$, SD $= .38$, $p = .09(95\%$ CI: .12 to $1.4)$]. There was no significant difference between the dyspareunia and the vaginismus group [M $-$ diff $= .67$, SD $= .41$ $p = .11$ $(95\%$ CI: .15 to $1.5)$].

A correlation analysis was conducted to further investigate the relationship between the GRISS, mean SDQ, the composite scores of the SVS (i.e., conservative and liberal) and the interaction between conservative and liberal. There were no significant correlations between the SDQ and the GRISS. Therefore, sexual dysfunctions were not associated with the readiness to perform certain sex-related actions. There was also no relationship between the conservative/liberal values or between liberal $\times$ conservative and the degree of sexual complaints. However, the SDQ showed a medium sized negative relationship with the conservative values $[r = -.40,\ p < .001]$ and a small sized positive correlation with the liberal values $[r = .20,\ p = .04,$ one-tailed].

A regression analysis was carried out to assess the ability of the SVS (conservative/liberal) and the conservative $\times$ liberal interaction term, to predict the strength of the SDQ scores. Liberal, Conservative and Liberal $\times$ Conservative were first centralized. The analysis showed that 31% of the variance is explained by the model $[R^2 = .31,\ F(3, 76) = 11.45,\ p < .001)]$. The strongest $\beta$ coefficient that contributed uniquely in the prediction of the SDQ was 'conservative' .55 followed by 'liberal' (slightly lower) .43. Therefore, both of the latter variables make a unique significant contribution to the model, i.e., in the prediction of the SDQ score (both $p < .001$). Liberal $\times$ Conservative was not found to make a significant unique contribution to the prediction of SDQ, with a $\beta$ coefficient of only 3%. Hence, the composite scales of the SVS each have independent predictive properties but their interaction showed no cumulative effect (see Table 3.1).

## 3.4 Discussion

This study investigated whether women inflicted with vaginismus (or dyspareunia) hold stronger adherence to conservative moral values than women without sexual problems. The findings can be summarized as follows: I) Specifically, the vaginis-

mus group showed relatively low scores on liberal values together with comparatively high scores on conservative values. II) Particularly the women with vaginismus were relatively (sexually) restricted in their willingness to participate in particular sex-related behaviours. III) This self-reported willingness to perform certain sex-related behaviours was independently associated with both the strength of conservative and liberal values. IV) The position of the dyspareunia group also shows relatively less willingness to participate in certain sex-related behaviours and relatively more adherence to conservative/less adherence to liberal values, but not significantly different from neither the vaginismus group nor from the healthy controls.

Our findings show that neither the liberal nor the conservative subscale differed significantly among the three groups. Nevertheless, in line with our hypothesis the group interaction indicates a differential value pattern among the three groups. It is worth noting that the patterns in women with dyspareunia lay between those with vaginismus and the control group. This lack of significant differentiation between vaginismus vs. dyspareunia, and dyspareunia vs. healthy control, might be due to insufficient power to reliably detect small effects. To arrive at more final conclusions in this respect, it would be important to replicate this study using a larger sample size.

In previous literature, it was found that women with sexual dysfunctions presented more sexually conservative standards. However, this was interpreted as possibly playing a part in particular sexual dysfunctions, such as sexual arousal disorders, but not considered as a feature that may contribute also to sexual pain disorders (Nobre and Pinto-Gouveia, 2006). Our findings may help to explain why previous research failed to find convincing evidence for the role of conservative values (on their own) in sexual pain disorders. Namely, the present results indicate that it is the collective effect of high conservative with low liberal, rather than high conservative per se, that seems characteristic of vaginismus, and possibly also (but to a lesser degree) of dyspareunia.

If these strict moral attitudes and/or high adherence to conservative values around sex have an effect on sexual arousal, they will directly and/or indirectly influence sexual absorption, which can trigger other difficulties with sexual expression (de Jong et al., 2010). Moreover, the perceived 'immorality' of sexual behaviour and the perceived moral impurity of sexual stimuli may not only disrupt sexual arousal, but might also play an active role in the defensive reflexes of the pelvic floor muscles that is distinctive for vaginismus (but less central in dyspareunia). Therapeutic examination of the patterns of moral principles that distinguish women with vaginismus could aid to understand further the strength of this (value) pattern-prototype, for instance by specifically testing whether indeed vaginistic symptoms

will also diminish following such an intervention.

In line with our expectations, women inflicted with vaginismus not only showed generally high adherence to conservative socio-moral principles (as indexed by the SVS), but were also more sexually restrictive in their willingness to perform certain sexual acts (as measured by the SDQ). The dyspareunia group did not differ significantly from the other two groups, yet similarly showed less willingness to perform the same sexual acts, when compared to controls. Having more restrictions around sex may increase the inclination of these women to frame sexual cues as wrongdoing. Transgressing from socio-moral values (perceived wrongdoing) or being the witness to such transgressions are powerful elicitors of disgust (i.e., socio-moral disgust) (Rozin et al., 2009). Perhaps then the previous finding that in women with vaginismus, watching a sex clip elicited enhanced muscular activity of the m. alesque nasii (a unique indicator of disgust expression) also reflects their relatively high adherence to conservative/sexually restrictive standards (Borg et al., 2010).

Earlier research has shown that the experience of disgust enhances further the strength of people's values (Schnall et al., 2008). Thus, transgression-induced disgust may further amplify the already existing restrictive sexual attitudes and motivate avoidance of particular sexual behaviour. In its turn, this will act in a way to maintain the sexual problems. Moreover, transgression can well elicit negative emotional reactions (e.g., socio-moral disgust). In the vaginismus group, the enhanced disgust responsivity towards sex stimuli, that was shown in previous research, together with the reduced willingness to perform certain sex acts, can further enhance the impact of the (already present) value patterns and their implications (Basson and Weijmar Schultz, 2007; Schnall et al., 2008). Perhaps the stronger involvement of disgust in vaginismus compared to dyspareunia may also help to explain, why the difference of the clinical groups versus healthy controls on general and sex-related moral standards, was especially pronounced for the vaginismus group.

Since this is a correlational study, the present findings allow no final conclusions regarding the direction of the relationship. Thus, it cannot be ruled out that women with vaginismus because they never experienced sexual intercourse, feel less inclined to perform sex-related actions. Consequently, they find less pleasure in performing sexual acts, or are simply less motivated to do so, as they never reach peak (or perceived peak) of penile-vaginal intercourse (Brody and Costa, 2009). The reduced willingness to perform these sexual acts can also operate as a mechanism driven by avoidance in itself or perhaps due to a lesser ability to relate to sexual pleasure. These latter mentioned assumptions are in line with our finding that the dyspareunia group is placed in between those of the vaginismus group and the group of women without sexual problems. Thus, successful intercourse in the women with dyspareunia (i.e., exposure, though with pain) may help with molding (some of)

the strict standards/attitudes around sex and to motivate them to actually perform certain sex-related actions that do not occur in the vaginismus group.

The weak correlation between the GRISS scores and socio-moral values suggests that there is no straightforward link between sexual satisfaction and people's values. Thus, the relatively low sexual satisfaction in women with vaginismus cannot be simply attributed to their high adherence to conservative/sexual restrictive values (nor can their high conservative, low liberal moral principles be attributed to low sexual satisfaction). The present pattern of findings suggests that conceivably, the relationship is due to other mediating mechanisms; for instance, strong values can trigger defensive responses in anticipation of penetration, which may well play a role in the symptoms of vaginismus and possibly also (but to a lesser degree) in the symptoms of dyspareunia (Borg et al., 2010).

### 3.4.1 Clinical implications

The present pattern of findings suggests that in vaginismus particularly, but to a lesser extent also in dyspareunia, a useful approach might be to examine and explore alternative perspectives for the females' sexually restrictive morals. High adherence to conservative values/sexually restrictive moral beliefs can share similarities to other types of dysfunctional beliefs in psychopathology. For instance in obsessive compulsive disorders, it has been shown helpful to explore the foundations underlying these particular dysfunctional beliefs and assumptions, in order to explore together with the client, whether there might be alternatives and/or more functional ways to appraise such situations. Negative beliefs shape the interpretations/appraisals of the sexual experience and when activated can induce distortion in processing. Thus, these cognitive distortions and behavioural responses may contribute to the maintenance of sexual pain disorders, as individuals are usually unable to reality-test their beliefs effectively. Moreover, once the misinterpretation develops, coping behaviour and selective biased attention to for instance internal events or stimuli contribute to further enhance the problems. Collaborative enquiry together with the patient, helps to keep confrontation or challenging beliefs to a minimum and the therapist can examine those beliefs that are either associated or interfere with the patient's ability to function sexually. Additionally, it might be beneficial to attempt neutralizing feelings of disgust that possibly mount-up in the process of transgressing rigidly held moral principles. It might also be relevant to explore (and minimize) other negative emotions that may help people to comply with their values (e.g., guilt and shame) arising from transgression, which simultaneously may play their part (Frank, 1988). Finally, it should be noted that more subtle interventions such as providing carefully selected books or other forms of

psycho-education should always be considered as part of an effective and holistic approach. These interventions may possibly also aid in helping the patient seek and be more open for relatively more invasive treatment interventions

### 3.4.2 Limitations

This study used subjective retrospective questionnaires, which can be influenced by self-presentational concerns (de Jong et al., 2009). Additionally, this study is correlational in nature and thus only allows relationships exploration between vaginistic/dyspareunic symptoms with a certain value pattern. Further experimental research is necessary to provide more solid grounds allowing for causal inferences. It would also be worthwhile to re-measure moral principles post treatment, to test whether they have decreased or held strong after intercourse, along with how this high adherence to conservative values (diminished/not) interplays with the symptomatology and the success of exposure to penetration stimuli.

### 3.4.3 Conclusion

To our knowledge, this is the first empirical study that investigated patterns of moral principles and sex-related attitudes as a specific dimension in women with vaginismus or dyspareunia. The findings are consistent with the view that low liberal and high conservative moral principles along with certain sexual attitudes may be involved in the development/maintenance of vaginistic symptoms (and to a lesser extent in dyspareunia). This suggests that targeting individuals' high adherence to conservative moral values may further enhance currently available (and promising) treatment strategies (ter Kuile et al., 2009; van Lankveld et al., 2006).

## Appendix 3.A. Values description

- **Traditionalism** is the average of the items 18, 32, 36, 44 and 51. The higher the scores on this value, the greater the attachment the individual holds for the respect of tradition and humility.
- **Conformity** is the average of the items 11, 20, 40 and 47. The higher the scores, the more that person tends to avoid actions and impulses that may harm others and/or violate social expectations or norms.
- **Security** is the average of the items 8, 13, 15, 22 and 56. Higher scores attribute greater value to safety, stability and harmony in society.
- **Hedonism** is the average of the items 4, 50 and 57. Higher scores reflect that greater value is ascribed to sensual pleasure or satisfaction.
- **Stimulation** is the average of the items 9, 25 and 37. The higher the scores, the more value is given to the creation of excitement, innovation and challenges.
- **Self-directedness** is the average of the items 5, 16, 31, 41 and 53. Higher scores reflect independence.
- **Power** is the average of the items 3, 12, 27 and 46. Higher scores indicate greater preference for elevated social status and prestige, along with control and dominance over other people and resources.
- **Achievement** is the average of the items 34, 39, 43 and 55. Higher scores mean that more value is given to personal success through demonstrating competence according to social standards.
- **Universalism** is the average of the items 1, 17, 24, 26, 29, 30, 35 and 38. Higher scores reflect stronger value placed on understanding, appreciation, tolerance and protection of others' welfare and nature in general.
- **Benevolence** is the average of the items 33, 45, 49, 52 and 54. Higher scores illustrate that more value is attached to maintaining and improving the welfare of other people one encounters.

## Appendix 3.B. Sexual disgust questionnaire: sex-related willingness

Instructions: in this questionnaire, you will be asked to imagine a number of situations. For each of the situations described, please indicate the extent to which you would be willing to participate in the behaviour on a scale ranging from 0 to 8. Mark the number that best reflects your judgment next to each statement.

Number in parenthesis (x) illustrates the actual question number in the 24-item SDQ, that is the only questions that were related to morality.

*The scale is defined as follows: 0 = definitely not willing, 2 = probably not willing, 4 = perhaps willing, 6 = probably willing, 8 definitely willing.*

To what extent are you willing to:

1. touch and carefully examine sex aids (e.g. a vibrator). (01)
2. watch a video in which someone is having sex with someone of the same sex. (04)
3. visit a gay bar. (05)
4. watch a video in which a man is tongue-kissing another man. (07)
5. watch a video clip in which one man is having sex with a woman. (15)
6. visit a sex shop. (18)
7. join a swinger group. (20)
8. attend a support group for people with a strong preference for atypical sex (e.g. paedophiles). (21)
9. watch a video clip in which your partner is masturbating. (23)

# Chapter 4

# Automatic vs. deliberate disgust response

**Abstract**

*The difficulty of penetration experienced in vaginismus and dyspareunia may at least partly be due to a disgust-induced defensive response. The aim of this study was to examine if sex stimuli specifically elicit: (i) automatic disgust-related memory associations; (ii) physiological disgust responsivity; and/or (iii) deliberate expression of disgust/threat. We used two single target Implicit Association Task (st-IAT) and electromyography (EMG) were conducted on three groups: vaginismus ($n = 24$), dyspareunia ($n = 24$), and control ($n = 31$) group. The outcome measures used in this study were st-IAT, to index their initial disgust-related associations and facial EMG for the m. levator labii and m. corrugator supercilii regions. Both clinical groups showed enhanced automatic sex-disgust associations. As a unique physiological expression of disgust, the levator activity was specifically enhanced for the vaginismus group, when exposed to a womenfriendly SEX film clip. Also at the deliberate level, specifically the vaginismus group showed enhanced subjective disgust toward SEX pictures and the SEX film clip, along with higher threat responses. Supporting the view that disgust is involved in vaginismus and dyspareunia, for both, clinical groups' sex stimuli automatically elicited associations with disgust. Particularly for the vaginismus group, these initial disgust associations persisted during subsequent validation processes and were also evident at the level of facial expression and self-report data. Findings are consistent with the notion that uncontrollable activated associations are involved in eliciting defensive reactions at the prospect of penetration as seen in both conditions. Whereas deliberate attitudes, usually linked with the desire for having intercourse, possibly generate the distinction (e.g., severity) between these two conditions.*

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## 4.1 Introduction

Vaginismus is characterized by *'persistent difficulties to allow vaginal entry of a penis/finger/object, despite the woman's wish to do so'* (Basson et al., 2004). It may occur in approximately 0.5-1% in women of childbearing age, although accurate estimations are lacking (Basson et al., 2004; Graziottin, 2008). The vaginistic complaints often have a chronic course and may result in considerable emotional distress (ter Kuile et al., 2007). Unfortunately, the aetiology of this contentious disorder is largely unknown. Nevertheless, recently designed treatment strategies with exposure to feared stimuli (i.e., targeted at penetration phobia) demonstrated that 90% of the sample reported intercourse following treatment, although they still failed in achieving levels of normal sexual functioning (ter Kuile et al., 2009). This finding supports the view that there are important similarities between vaginismus and anxiety disorders (Watts and Nettle, 2010).

Several factors can be playing a role in vaginismus with recent accentuate on its psychological component (ter Kuile et al., 2007, 2009). Recently, it has been argued that disgust and fear of contamination may be involved in vaginismus (de Jong et al., 2009). Disgust is seen as a defensive mechanism protecting the organism from contamination by pathogens (Rozin and Fallon, 1987). Consequently, it centers on the intersection between the body and the environment and concentrates on the skin and body apertures. Disgust responsivity increases as a function of proximity of the potential contaminant and the sense of inclusion (Rozin et al., 1995; Fessler and Haley, 2006). Hence the various body parts differ in their contamination sensitivity; with mouth, vagina, and penis holding the highest subjective contamination sensitivity, together with body products such as sweat and semen as the strongest disgust elicitors (Davey et al., 1993; Rozin and Fallon, 1987). Given the core role of these organs and their products in sexual behaviour, it is difficult not to see the link between the two ends.

Disgust is highly associated with avoidant tendencies and defensive reflexes that may help to protect and to avoid (the anticipated) contamination (Yartz and Hawk, 2002). This could also be reflected in the involuntary contraction of the pelvic floor muscles which has been shown to be part of a general defense mechanism (van der Velde et al., 2001; Oaten et al., 2009). Consequently, the prospect of mere physical contact with the vagina and/or the anticipation of penetration by the partner's penis may well elicit involuntary pelvic floor muscle activity (van der Velde et al., 2001; Rozin et al., 1995). From this perspective, vaginismus may at least be partly due to a disgust induced defensive response.

Consistent with this, women with vaginismus were found to display generally enhanced levels of trait disgust propensity (de Jong et al., 2009; Haidt et al., 1994).

However, this earlier study, which relied exclusively on explicit self-report measures, provided no convincing evidence that these women also showed stronger disgust responsivity toward sexual stimuli (de Jong et al., 2009). Thus, these results might have been influenced by demand and may not accurately reflect the actual attitudes toward sexual stimuli. In addition, current dual process models emphasize the importance to differentiate between more deliberate, reflective attitudes and more automatic reflexive associations in memory (Gawronski and Bodenhausen, 2006). Both types of cognitions are believed to have different functional qualities. Explicit attitudes are assumed to reflect the outcome of the weighting of propositions and their corresponding 'truth' values (i.e., validation processes), while automatic associations are alleged to follow from the direct activation of simple associations in memory, independent of their true value. Explicit cognitions tend to predict more deliberate behaviours, whereas automatic associations seem to play an important role in guiding relatively spontaneous behaviours, the kind of behaviours that seem also critically involved in disgust-and/or threat induced defensive behaviour (Egloff and Schmukle, 2002; Huijding and de Jong, 2005). Therefore, it might well be that uncontrollable automatically activated associations are a crucial factor in eliciting the characteristic defensive reactions in women suffering from vaginismus.

In this study, we used a (st-IAT) to index initial disgust and threat-related associations in response to pictures showing sexual intercourse (Huijding and de Jong, 2007). As a further (more implicit) test of the role of disgust responsivity, we also recorded facial electromyography(EMG) of the levator labii muscle as a physiological marker of disgust (Vrana, 1993). To minimize demand and self-presentational concerns, we used stimuli that did not directly refer to the patient's partner (as it has been done in the earlier study) (de Jong et al., 2009).

## 4.2 Aim

The major aim of this study is to investigate further, whether disgust is indeed involved in vaginismus, by examining if, specifically, women with vaginismus elicit (i) automatic and/or deliberate disgust-related associations; and/or (ii) facial expressions of disgust during the presentation of pictures and a film clip with penievaginal penetration content.

## 4.3 Method

### 4.3.1 Participants

In order to test the specificity of enhanced disgust responsivity in vaginismus, we included both a control group of women without sexual complaints and a clinical control group of women suffering from dyspareunia (a sexual dysfunction from the same diagnostic category as vaginismus; sexual pain disorders). Whereas the inability to have sexual intercourse is most central to vaginismus, for dyspareunia, recurrent genital pain is the defining feature (DSM-IV-TR, 2000). Although disgust-related preoccupations might also contribute to dyspareunia, current views emphasize the role of fearful preoccupations with painful intercourse in the maintenance of dyspareunia (Reissing et al., 2004). Thus, there were three groups: a primary lifelong vaginismus group ($n = 24$, mean age $= 30.1$; SD $= 5.6$), a dyspareunia group ($n = 24$, mean age $= 28.8$; SD $= 6.9$), and healthy controls ($n = 31$, mean age $= 29.7$; SD $= 7.2$). Both clinical groups (vaginismus and dyspareunia) were recruited from the University Medical Center Groningen. There was no significant age difference ($p$ = 0.80) between the three groups.

An experienced gynecologist and sexologist examined both clinical groups, using a validated semi-structured sexual interview. In addition, the diagnostic procedure included a physical examination. In this study, the extended definition of vaginismus was used in line with earlier studies, namely *'persistent or recurrent difficulties to allow vaginal entry, where structural or physical abnormalities were ruled out during the physical examination'* (Basson et al., 2004; de Jong et al., 2009; De Kruiff et al., 2000). Therefore, for our sample, the diagnosis of vaginismus was made based on these criteria formulated by Basson et al. The diagnosis of dyspareunia was characterized by persistent or recurrent pain with attempted or complete vaginal entry and/or penile vaginal intercourse (Basson et al., 2004; de Jong et al., 2009). For the diagnosis, dyspareunic symptoms had to be present minimally in 50% of the intercourse attempts and at least for a period of 6 months. The Medical Ethical Committee of University of Groningen approved this study and all work was carried out according to its standard.

## 4.4 Main outcome measures

### 4.4.1 st-IAT

The st-IAT is a computerized reaction time (RT) task that measures the extent to which a single target category (in this case, sexual penetration) is associated with

two attribute categories (in this case, disgusting/nice and threatening/safe) (Huijding and de Jong, 2007). In earlier studies, the st-IAT already proved to be sensitive to group differences in automatic associations (Huijding and de Jong, 2006a). This implicit measure is difficult to modulate or to fake its responses (vs. self-report measures), with high reliability. Therefore, when automatic associations are possibly below the conscious awareness, st-IAT is an indicated measure to assess automatic associations with that particular target, here the sex stimuli.

In this study, two different st-IATs were used, namely disgust st-IAT and a threat st-IAT, to measure two types of associations with sexual penetration. In both st-IATs, pictures with sexual penetration content formed the (single) target in the task, and the attributes consisted of disgust vs. nice words in case of the disgust st-IAT and threat vs. safe words in case of the threat st-IAT.

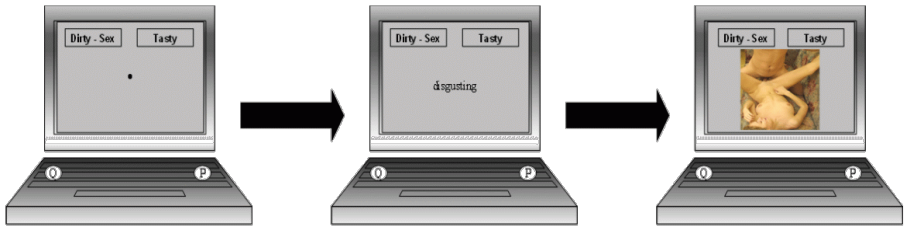


Figure 4.1: st-IAT, reaction time task

Both st-IATs consisted of two test phases preceded by a practice phase. Participants were instructed to categorize words of the three categories that appeared in the middle of a computer screen by means of two response buttons. In one test phase, 'sex' and 'disgust' (threat') were mapped on a single response key and 'nice' ('safe') on the other. In the other test phase, 'sex' and 'nice' ('safe') were mapped on a single key and 'disgust' ('threat') on the other. The idea is that the task becomes easier (and the responses faster) when two categories that are strongly associated share the same response key. Consequently, the difference in RTs between both test phases is assumed to reflect whether sex is associated more strongly with either attribute category.

During the task, the labels of the categories assigned to the left and right keys were presented in the upper left and right corners of the screen, respectively. Following a correct response, the stimulus was immediately replaced by a fixation dot in the middle of the screen, which was replaced by the next stimulus after 500 $ms$. Following an incorrect response, the Dutch word 'FOUT' (false) appeared shortly above the stimulus. The stimulus remained on the screen until the correct answer

was given. The order of st-IATs was counterbalanced (Huijding and de Jong, 2006a).

Computerized visual analogue scales ranging from 0 (= Disgusting, or Threatening) to 9 (= Nice, Safe) were used for measuring participants' subjective evaluation of the target sex pictures.

### 4.4.2 Facial EMG

Facial EMG was recorded for the m. Corrugator supercilii and the levator labii regions, via pairs of 2.8mm Ag-AgCI electrodes, placed on the left side of the face, according to standard recommendations (Fridlund and Cacioppo, 1986). The levator alesque nasii muscle was selected due to its activity specific to disgust relative to other negative emotions (Wolf et al., 2005; Vrana, 1993). The m. corrugator supercilii has been included to index general negative affect (see picture below).

(a) (b)

Figure 4.2: Facial EMG on the levataor alesque nasii as a unique indicator of disgust and on the corrugator muscle as a control for general negative affect. The woman in the photo is Ms Inge Vriese, who together with Ms Marijke Zwaan and Ms Aafke Vogelzang - conducted most of the testing in this study

We used four categories of pictures that were taken from the International Affective Picture System (IAPS) (Lang et al., 1999). Specifically, these consisted of sexual penetration (non-IAPS), disgusting scenes (IAPS: 9300; 9320; 9290; 9340; 9373), threatening scenes (IAPS: 1120; 1301; 6200; 6300; 9400), and neutral (IAPS: 7025; 7009; 7175; 7190; 7185) stimuli.

In addition to measuring facial EMG during the presentation of discrete stimuli, we also measured disgust responsivity during the presentation of (more intense) film material. We showed two clips of 5 minutes each: a baseline control clip and a

female-friendly erotic clip (in that order). The baseline clip was about the production of handmade glass (Bert Haanstra), while the erotic female-friendly film clip consisted of a male and female in the core of their sexual act.

## 4.5 Procedure

The experiment took place in a sound attenuated room, divided from the experimenter's room by a one-way screen. First, participants completed the st-IATs and then they were seated in front of a large projection screen ($1.5$m $\times$ $1.5$m) and were shown the pictures (five examples for each affective category, presented in a random fixed order) followed by the clips. Subjective evaluation of the picture stimuli and the film clips were assessed after each individual procedure.

### 4.5.1 Data reduction and analysis

In line with previous research, st-IAT effects were computed on the basis of the attribute trials only (Huijding and de Jong, 2006a). Pictures (here, the targets) are processed differently from (attribute) words. In addition, the targets in this study did not require a decision based on content. Participants were extremely fast on picture trials, and interference due to automatic associations seems most likely during attribute trials (Huijding and de Jong, 2006a). St-IAT effects (i.e., the so-called $D_4$-Measure) were computed according to the now widely used scoring algorithm (Greenwald et al., 2003). Following these guidelines, all RTs above 10,000 $ms$ were discarded. Error trials were replaced with the mean RT of the correct responses in the block in which the error occurred, plus a penalty of 600 $ms$. The st-IAT effects were calculated by subtracting the mean RT of Block 2(4) from Block 4(2) (test). The mean of these two effects was divided by their pooled SD. In this paper, we report the $D_4$-measure (see Table 4.2). Negative st-IAT effects (i.e., negative $D_4$-measure) indicate relatively fast responses when sex shared the response key with either disgust or threat. Hence, here, negative $D_4$-measure means more automatic associations of sex with either disgust or threat.

EMG data were processed online over the frequency range of 60 - 1,000 Hz. For the slides, response magnitude was calculated as the difference in the mean (integrated) EMG activity during slide exposure and mean activity during the $100ms$ pre-slide interval. This was performed for each muscle (corrugator, levator) separately.

## 4.6 Results

For both st-IATs, RTs (as a function of block) and $D_4$ measure scores are shown in Table 4.1 and Table 4.2, respectively:

Table 4.1: Reaction Time in $ms$

| | | Vaginismus $N = 24$ | | Dyspareunia $N = 24$ | | Controls $N = 31$ | |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | M | SD |
| Disgust st-IAT | RT Sex Disgust (Neg) | 712 | 125 | 684 | 135 | 686 | 100 |
| | RT Sex Nice (Pos) | 736 | 117 | 712 | 153 | 657 | 81 |
| Threat st-IAT | RT Sex Threat (Neg) | 834 | 209 | 777 | 151 | 736 | 116 |
| | RT Sex Safe (Pos) | 859 | 191 | 802 | 194 | 736 | 129 |

Reaction time in ms is given for each category. RT = reaction time; SD = standard deviation; st-IAT = single target Implicit Association Task.

Table 4.2: $D_4$ measure for each group for both IATs

| | Vaginismus $N = 24$ | | Dyspareunia $N = 24$ | | Clinical Group $N = 48$ | | Controls $N = 31$ | |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD |
| Disgust st-IAT | $-.06$ | .40 | $-.09$ | .33 | $-.08$ | .36 | .12 | .31 |
| Threat st-IAT | $-.09$ | .40 | $-.06$ | .44 | $-.08$ | .41 | .03 | .34 |

SD = standard deviation; st-IAT = single target Implicit Association Task.

### 4.6.1 Disgust st-IAT

The difference between groups was of an intermediate to large effect size [$F(2, 76) = 3.44,\ p < .05,\ \eta^2 = .08$]. Paired comparisons (LSD) indicated that both the vaginismus group and the dyspareunia group showed significantly stronger disgust associations than the controls, (M $= -.19$; SD $= .09,\ p < .05$) and (M $= -.22$; SD $= .09,\ p < .05$), respectively. The difference between the clinical groups was not significant ($p > .73$) (see Table 4.2[1]).

### 4.6.2 Threat st-IAT

For the Threat IAT, the between group difference was small and not significant [$F(2, 76) = .80$, $p = .45$, $\eta^2 = .02$] (see Table 4.2).

[1] In the published paper which we base this chapter on, we used milliseconds rather than the so called $D_4-$measure as described in the method section. We now here reported the actual $D_4-$measure which is generated from the difference in reaction times (which had no effect on the findings).

### 4.6.3 Facial EMG during disgust and threat pictures

EMG responses while looking at picture stimuli were subjected to a 3 Group (Vaginismus, Dyspareunia, Controls) $\times$ 3 Stimuli (Neutral, Disgust, Threat) $\times$ 2 Muscles (Levator labii, Corrugator supercilii) analysis of variance (ANOVA), with Stimuli and Muscle being within-subject factors. There was a main effect of Stimulus [$F(2, 68) = 15.8,\ p < 0.001,\ \eta^2 = 0.32$], demonstrating that the content of the stimuli granted diverse EMG activation. These effects were similar for all groups $Fs < 1$ with no distinction between the two muscles [$F(1, 69) = 1.79,\ p = 0.18$]. Thus, there was no evidence indicating that women with vaginismus are characterized by a generalized enhanced responsivity to disgust and/or threat stimuli. Supporting the validity of the stimulus materials, pairwise comparisons demonstrated that the DISGUST vs. NEUTRAL (M $= 7.3$; SD $= 4.15,\ p < 0.001$) and DISGUST vs. THREAT pictures (M $= 16.6$; SD $= 3.79,\ p < 0.001$) elicited significantly stronger levator activation, but in line with our hypothesis, this was not the case for THREAT vs. NEUTRAL pictures (M $= 0.73$; SD = $2.21,\ p = 0.74$). Similarly, for the corrugator muscle, there was a significant difference between DISGUST vs. NEUTRAL (M $= 16.6$; SD $= 4.78,\ p < 0.001$) and between DISGUST and THREAT (M $= 21.1$; SD $= 4.30,\ p < 0.001$) but not between NEUTRAL and THREAT pictures (M $= 4.47$; SD $= 2.88,\ p = 0.12$).

### 4.6.4 Facial EMG during sex pictures

#### M. levator labii

Although the pattern was in the predicted direction with relatively high activation of the levator labii in the vaginismus group (M $= 36.4$; SD $= 33.6$), relatively low in the control group (M $= 21.1$; SD $= 39.3$), and with the dyspareunia group in between (M $= 26.2$; SD $= 27.5$), this pattern did not reach significance ($F[2, 69] = 1.21,\ p > 0.30$).

#### M. corrugator supercilii

One-way anova indicated that there were no significant differences between the groups ($F[2, 72] = 0.115,\ p > 0.89$).

### 4.6.5 Facial EMG during film clip

#### M. levator labii

The relevant contrast (Erotic minus Neutral) was subjected to one-way anova. In line with our hypothesis, levator activity was larger for vaginismus than for the control or dyspareunia groups, [M $= 2.23$; SD $= 1.10,\ p < 0.05$ and M $= 3.27$; SD $= 1.16,\ p < 0.05$], respectively. The dyspareunia group did not differ significantly from the controls (M $= 1.04$; SD $= 1.1,\ p = 0.35$).

#### M. corrugator supercilii

Responsivity of the corrugator supercilii did not differ between groups ($F[2, 70] = 0.37,\ p = 0.69$).

### 4.6.6 Subjective ratings of the pictures

Subjective ratings of the pictures are shown in Table 4.3, as a function of stimulus type, affective dimension, and group.

Table 4.3: Subjective ratings of stimuli

| | Control Group | | Vaginismus Group | | Dyspareunia Group | |
|---|---|---|---|---|---|---|
| | Disgust | Threat | Disgust | Threat | Disgust | Threat |
| Sex Pictures | $41(30)^a$ | $11(19)^b$ | $57(31)^d$ | $33(32)^c$ | $36(27)^a$ | $20(23)^{bc}$ |
| Disgust Pictures | $75(16)^a$ | $20(17)^b$ | $69(16)^a$ | $17(19)^b$ | $73(17)^a$ | $17(14)^a$ |
| Threat Pictures | $31(23)^a$ | $65(18)^b$ | $28(21)^a$ | $48(27)^c$ | $34(19)^a$ | $55(18)^{bc}$ |

Means are provided for each group on two dimensions (disgust, threat) with (SD) in parenthesis for the three categories. Different letters in superscript (e.g., a/b/c/d) show significant difference, while same letters (e.g., a/a) show no significance/interaction.

#### Disgust pictures

For the DISGUST pictures, there was no significant effect of group ($F[4, 152] = 0.51,\ p = 0.73$). As expected, there was a main effect of response, showing higher subjective disgust than threat response ($F[2, 76] = 7.71,\ p < 0.05$). This effect was similar for all groups ($F[2, 77] = 0.19,\ p < 0.83$).

#### Threat pictures

There was a main effect of Response ($F[1, 77] = 114,\ p < 0.001,\ \eta^2 = 0.60$) demonstrating heightened subjective threat than disgust, and a main effect of Group

($F[2, 77] = 6.36,\ p < 0.05,\ \eta^2 = 0.142$; Roy's Largest Root $= 0.17$). When the dependent variables were considered separately, only for Threat, the difference between groups reached statistical significance ($F[2, 77] = 4.94,\ p < 0.05$). Post hoc tests (LSD) showed that the vaginismus group differed significantly from the control group with higher responses (M $= 17.85$; SD $= 5.74,\ p < 0.05$ [95% CI: 6.42 to 29.28]) but not from dyspareunia (M $= 7.81$; SD $= 6.14,\ p = 0.21$ [95% CI: 4.40 to 20.04]), and neither did dyspareunia from the controls (M $= 10.03$; SD $= 5.74,\ p = 0.08$ [95% CI: 1.39 to 21.47]).

**Sex pictures**

A 3 Group (controls, vaginismus, dyspareunia) $\times$ 2 Response (threat vs. disgust) anova showed a main effect of Group that was qualified by a Group $\times$ Response interaction ($F[4, 152] = 3.63,\ p < 0.05$; Wilks' $\lambda = 0.83,\ \eta^2 = 0.09$). Subsequent analysis restricted to the threat dimension showed a significant effect of Group ($F[2, 77] = 5.63,\ p < 0.05,\ \eta^2 = 0.13$). For the disgust dimension, a main effect of group was also demonstrated ($F[2, 77] = 3.33,\ p < 0.05,\ \eta^2 = 0.08$). Paired comparisons indicated that the vaginismus group showed significantly higher subjective threat than controls (M $= 22.36$; SD $= 6.66,\ p < 0.05$ [95% CI: 35.6 to 9.09]). There was a non significant tendency indicating that the threat scores were also higher for the vaginismus than for the dyspareunia group (M $= 12.8$, SD $= 7.12,\ p = 0.07$). The difference between the dyspareunia group and controls did not approach significance (M $= 9.55$; SD $= 6.66,\ p = 0.15$). Analysis restricted to the disgust response showed that the vaginismus group differed significantly from the dyspareunia group (M $= 20.7$; SD $= 8.44,\ p < 0.05$ [95% CI: 3.89 to 37.5]) and controls (M $= 17.72$; SD $= 7.90,\ p < 0.05$ [95% CI: 31.46 to 0.01]). There was no difference between the dyspareunia group and controls (M $= 4.98$; SD $= 7.90,\ p = 0.53$ [95% CI: 20.73 to 10.74]).

### 4.6.7 Subjective rating of the film clips

A 3 Groups $\times$ 2 Responses (threat/disgust) $\times$ 2 Film (sex vs. neutral) anova showed the predicted Group by Film interaction ($F[2, 75] = 5.33,\ p < 0.05,\ \eta^2 = 0.13$). There were no significant differences between groups toward the NEUTRAL film ($F[2, 75] = 0.749,\ p = 0.48$). In line with our hypothesis, for the SEX film, there was a Group $\times$ Response interaction ($F[2, 75] = 5.78$, Roy's Largest Root $= 0.15,\ p < 0.05,\ \eta^2 = 0.13$). Subsequent analyses indicated that there was a significant difference between groups for threat ($F[2, 75] = 5.03,\ p < 0.05,\ \eta^2 = 0.12$), whereas the similar tendency for disgust did not reach significance ($F[2, 75] = 2.38,\ p = 0.09,\ \eta^2 = 0.06$). Posthoc (LSD) tests showed that subjective threat

was significantly higher in the Vaginismus group than in the controls (M $= 1.71$; SD $= 0.54$, $p < 0.002$ [95% CI: 2.79 to 0.64]). There was a non significant tendency indicating that the threat scores were also higher for the vaginismus than for the dyspareunia group (M $= 0.96$; SD $= 0.57$, $p < 0.09$ [95% CI: 0.17 to 2.10]). Moreover, there was no difference between dyspareunia and controls (M $= 0.75$; SD $= 0.53$, $p > 0.16$ [95% CI: 1.81 to 0.31]). On the dimension of disgust, the vaginismus group indicated higher scores than controls (M $= 1.13$; SD $= 0.65$, $p < 0.08$ [95% CI: 2.47 to 0.17]). There was no difference between dyspareunia and control group (M $= 0.30$; SD $= 0.64$, $p < 0.65$ [95% CI: 0.99 to 1.58]). However, vaginismus differed from the dyspareunia group (M $= 1.42$; SD $= 0.69$, $p < 0.04$ [95% CI: 0.045 to 2.80]).

## 4.7 Discussion

The core findings can be summarized as follows: (i) Women with vaginismus or dyspareunia showed enhanced associations between sex and disgust; (ii) Specifically women with vaginismus also showed heightened levator activity when exposed to an erotic clip; (iii) The vaginismus group showed enhanced subjective disgust along with threat; (iv) Exposure to slides depicting penetration did not result in a differential pattern in levator activity, whereas specifically women with vaginismus again showed increased subjective disgust; and (v) There was no evidence indicating that women with vaginismus are characterized by a generalized amplified levator and/or subjective responsivity to disgust and/or threat stimuli.

Recent clinical reviews reinforce the known hazy distinction between dyspareunia and vaginismus and seem to suggest that these conditions can be better taken on a continuum of sexual pain disorders rather than two separate entities (Crowley et al., 2009; Klaassen and Ter Kuile, 2009). Previous studies investigating the diagnosis of vaginismus showed that clear diagnostic agreement distinguishing vaginismus from dyspareunia was difficult, particularly on vaginal spasm and pain measures (Reissing et al., 2004). This lack of clear distinction is also shown in this study, since both clinical groups showed similar st-IAT performance. Our findings suggest that automatic disgust associations are involved in both dyspareunia and vaginismus, which may also help explain the similarities in symptomatology. Perhaps most important, disgust-induced defensive responding may explain the shared difficulties associated with vaginal penetration (either completely impossible or partially possible with pain). In addition, automatic disgust associations could also interfere with the normal process of arousal, thereby enhancing the probability that (attempts of) penetration inflicts pain (Laan and Both, 2008).

However, the vaginismus and the dyspareunia group showed differential sub-

jective and muscular responsivity towards the SEX stimuli. Specifically, only the women with vaginismus showed significantly enhanced subjective disgust and enhanced facial expressions of disgust (as indexed by levator responsivity). Apparently, in the vaginismus group, in contrast to the dyspareunia group, the validation process does not give rise to a correction of the initial (sex-disgust) associations. Perhaps, this may help in explaining why penetration is still possible in dyspareunia (although painful) but not in vaginismus (Gawronski and Bodenhausen, 2006). This is in line with previous research showing that women with vaginismus, compared to dyspareunia/provoked vestibulodynia, expressed significantly higher avoidance behaviour during either physical examination or past (attempts of) intercourse (Reissing et al., 2004).

The absence of generally enhanced disgust responsivity in our results, is in apparent conflict with earlier findings showing that vaginismus is characterized by heightened disgust propensity (de Jong et al., 2009). Perhaps, this difference can be attributed to the fact that the previous study used a retrospective trait-like questionnaire measure, whereas the present study used a state measure assessing individuals' current response upon exposure to concrete stimuli. Further research is necessary to arrive at more final conclusions in this respect. Most importantly, this study clearly showed that specifically the vaginismus group responded with enhanced disgust responsivity when exposed to sex stimuli, both in terms of facial expressions and in terms of subjective evaluations.

Although this study looked at sexual dysfunction with particular emphasis on vaginismus, the active processes underlying vaginismus can also be involved in other similar disorders, which were found at high frequency with vaginismus, e.g., dyspareunia, and hypoactive desire (Dogan, 2009; de Jong et al., 2010).

### 4.7.1 Clinical implications

Automatic associations are assumed to be linked to uncontrollable physiological responses, e.g., defensive contraction of pelvic floor muscles (Huijding and de Jong, 2006a). In addition, deliberate as well as automatic sex-disgust associations can potentially trigger disgust-related appraisals, involuntarily disgust-attention-attraction properties, and negative interpretation of ambiguous cues (de Jong et al., 2010). These may all interfere with the generation of sexual arousal (de Jong et al., 2009). Considering the role of disgust in both vaginismus and dyspareunia, this may thus provide some fresh clues that may aid in refining further the currently available interventions (ter Kuile et al., 2009; Yasan and Akdeniz, 2009). For example, it may be helpful in cognitive behavioural therapy to explore a focus on contamination-related preoccupations, and to include exposure exercises aiming at

reducing the contamination potency of sexual products and/or the contamination sensitivity of the individual's body parts (de Jong et al., 2010). Future efforts to explore and test interventions targeted at reducing disgust-related feelings/appraisals as an augmentation to the current available treatment may lead to welcome contributions to the present techniques.

### 4.7.2 Limitations

The present study relied on sex stimuli presented under laboratory conditions. Hence, it remains to be seen whether similar results will emerge in real life contexts. Moreover, it could be speculated that the pictures shown more readily elicit disgust associations compared to 'real' sex. If so, this might have undermined the sensitivity of the st-IAT to find meaningful differences between vaginismus and dyspareunia. However, the finding that differential disgust responsivity did emerge at the level of facial expressions renders this suggestion not very convincing. It should be acknowledged that the difference in physiological disgust responding between vaginismus and dyspareunia was only significant for the film clip; yet, this is probably due to the fact that a clip is more intense and close to reality.

Moreover, a limitation that should be mentioned here is that provoked vestibulodynia was not uniquely used as a critical diagnostic criterion for the dyspareunia group due to uncertainties of its aetiology and multifactorial cause of its symptoms. We kept in line with the design of previously conducted diagnostic studies (Reissing et al., 2004). Therefore, it remains to be seen in future research whether perhaps there are meaningful differences between subtypes of dyspareunia that may also bear on the role of disgust in this sexual pain disorder.

## 4.8 Conclusions

This study is the first to show that, indeed, automatic sex-disgust associations characterize women suffering not only from vaginismus, but also those inflicted with dyspareunia. It was found that, particularly in the vaginismus group, these associations endure and are expressed on a deliberate level. The application of this research may aid in the refinement of the present conceptualization of vaginismus and dyspareunia. This is not only of theoretical relevance but may also help to improve the currently available treatment options.

## Section II

# Neural correlates of disgust and disorder specific stimuli

# Chapter 5

# Disgust trait modulates frontal-posterior coupling as a function of disgust domain

**Abstract**

*Following the two-stage model of disgust, 'core disgust' (e.g., elicited by rotten food) is extended to stimuli that remind us of our animal nature 'AR disgust' (e.g., mutilations, animalistic instincts). There is ample evidence that core and AR represent distinct domains of disgust elicitors. Moreover, people show large differences in their tendency to respond with disgust to potential disgust elicitors (propensity) as well as in their appraisal of experiencing disgust (sensitivity). Thus these traits may be important moderators of people's response patterns. Here we aimed to find brain mechanisms associated with these distinct disgust domains and traits, as well as the interaction between them. The right ventrolateral occipitotemporal cortex, which preferentially responded to visual AR, was functionally coupled to the middle cingulate cortex (MCC), thalamus, and prefrontal cortex (medial, dorsolateral), as a function of disgust domain. Coupling with the anterior part of MCC was modulated by disgust propensity, which was strongest during AR. Coupling with anterior insula and ventral premotor cortex was weaker, but relied fully on this domain-trait interaction. Disgust sensitivity modulated left anterior insula activity irrespective of domain, and did not affect functional connectivity. Thus a frontal-posterior network that interacts with disgust propensity dissects AR and core disgust.*

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## 5.1 Introduction

Disgust is conceptualized as an avoidant-defensive mechanism that evolved to prevent the body from contamination by spoiled foods. According to theories of disgust (Curtis et al., 2004; Rozin and Fallon, 1987; Rozin et al., 1995), this mechanism of 'core disgust' stretched to more complex domains such as sociomoral disgust and animal-reminder (AR) disgust. AR disgust may be triggered by reminders of mortality, mutilation, and intrinsic animalistic instincts (Rozin et al., 1999), cues that remind us of our animal ancestry. This disgust-mediated rejection of our animal nature is argued to serve a defensive function for maintaining the hierarchical division between humans and animals (Haidt et al., 1994). Though often treated as a single category, core and AR disgust can be systematically distinguished as separate concepts in factor analytical studies (van Overveld et al., 2009), with distinct patterns of behavioural avoidance and associated psychopathologies like contamination-based Obsessive Compulsive Disorder (OCD) (Olatunji et al., 2007, 2008) versus blood-injury fears (de Jong and Merckelbach, 1998).

Brain areas consistently associated with disgust across neuroimaging studies include anterior insula, frontal operculum, amygdala, occipitotemporal cortex, orbitofrontal cortex, caudate-putamen, and globus pallidus (Murphy et al., 2003; Phan et al., 2002; Zald et al., 2002), but few studies have taken disgust domains into account. Yet, recent evidence suggests that core and AR-like disgust experiences draw upon distinct peripheral physiological activity and separable responses in the anterior insula (Harrison et al., 2010), whereas core and moral disgust have been shown to elicit differential activation at the level of the amygdala (Moll et al., 2005; Schaich Borg et al., 2008). These studies provide further support that disgust carries subcategories that are fundamentally distinct. In direct comparisons between AR and core conditions, brain responses to AR-like stimuli (e.g., mutilation) tend to be stronger, most notably in occipitotemporal (Sarlo et al., 2005) and parietal (Schienle et al., 2006; Wright et al., 2004) cortices.

Of note, stimuli in these studies may have been suboptimal, in that they had not meticulously represented and distinguished AR and core disgust. For instance, a movie of a clean surgical procedure (Harrison et al., 2010) does not necessarily fall within the realm of AR. Additional complexity is introduced when we consider that individual differences in disgust traits have been found to critically modulate subjective (van Overveld et al., 2009) and physiological disgust responses (van Overveld et al., 2010; Rohrmann and Hopp, 2008), and that these traits seem to interact with disgust domain in the origin and maintenance of psychopathological symptoms (de Jong and Merckelbach, 1998; Olatunji and Sawchuk, 2005; Sawchuk et al., 2000). Disgust traits comprise of individual differences regarding people's threshold

for experiencing disgust (propensity), as well as regarding their appraisal of the experienced disgust responses (sensitivity). That is, people not only vary in their tendency to experience the emotion of disgust more readily but also in their tendency to find the emotion of disgust unpleasant. High disgust propensity may increase the probability that stimuli acquire disgust-evoking properties which could lead to avoidance behaviour (de Jong and Muris, 2002). In turn this avoidance would be especially pronounced in individuals who appraise the experience of disgust as highly negative (van Overveld et al., 2009). Attesting further to the relevance of differentiating between disgust propensity and sensitivity, both traits have been shown to be differentially involved in psychopathology (Engelhard et al., 2011; Olatunji et al., 2007). Disgust-related brain responses that correlate with propensity disgust trait include the insula, ventral pallidum and occipitotemporal cortex (Calder et al., 2007; Mataix-Cols et al., 2008; Schaefer et al., 2009; Schienle, Schafer, Stark, Walter and Vaitl, 2005), whereas sensitivity disgust trait was negatively associated with medial and dorsolateral prefrontal activity (Schaefer et al., 2009). However, the potentially important interaction between specific disgust traits (propensity, sensitivity) and disgust domains (AR, core) has so far been overlooked.

All these accounts support the claim that disgust extends far beyond filth. Disgust responses seem (at least partly) domain-specific, and people show remarkable differences in their responsivity to potential disgust elicitors as well as in their appraisals of the experience of disgust. Here we aim to reveal the complexities/intricacies of disgust by searching brain mechanisms that express an interaction between disgust domain (AR, core) and putative disgust traits (sensitivity, propensity).

## 5.2 Materials and methods

### 5.2.1 Participants

Twenty-one healthy women [mean age ($\pm$SD), 22 ($\pm$2.1)] participated in this study against modest financial reimbursement. All participants had normal or corrected-to-normal vision, no structural brain abnormality, and no past neurological or psychiatric history. One volunteer was excluded because of excessive head motion and poor compliance. This experiment, which is part of a larger project, was approved by the local ethics committee and all procedures were conducted in accordance with its standard, which includes a written informed consent from all participants. Participants were scanned in the first half of their menstrual cycle and never during menstruation. About 20% of the sample did not make use of contraceptives, whilst 80% used oral contraceptives. All participants reported moderate alcohol and nico-

tine consumption at most, and all denied drug use. Apart from two participants, all were exclusively right handed according to the Edinburgh Handedness Inventory (Oldfield, 1971). Participants were recruited via the local media, by means of a website designed for this study, and by advertisements that were attached at various sites of the University Campus. All women self-selected themselves for participating as healthy controls in an on-going study about cognitive processes in women with sexual pain disorders.

### 5.2.2 Self-report disgust trait questionnaires

The Disgust Propensity and Sensitivity Scale (DPSS-R) is a 12 item questionnaire that consists of two validated subscales that measure trait disgust propensity and trait disgust sensitivity, respectively (van Overveld et al., 2006). The validated shortened version was used (Fergus and Valentiner, 2009). Participants read twelve propositions on the frequency of experiencing bodily sensations (e.g., 'Disgusting things make my stomach turn' for propensity, and 'I think feeling disgust is bad for me, It scares me when I feel like fainting' for sensitivity), and indicated which applied best to them on a scale from 1 (never) to 5 (always). The DPSS-R has been validated and used in a number of studies (van Overveld et al., 2006) and it is the first index that measures disgust propensity and disgust sensitivity irrespective of disgust elicitors (Cavanagh and Davey, 2000). The scale has been shown to be internally consistent (van Overveld et al., 2006), and has shown predictive validity for experienced disgust in disgust-eliciting experimental tasks across all relevant disgust domains (van Overveld et al., 2010). In previous studies the scale was shown to be reliable, with the DPSS-R and its subscales' internal consistency all above Cronbach's alpha of .78 (Fergus and Valentiner, 2009; van Overveld et al., 2011). In our sample the Cronbach's alpha for disgust sensitivity was $(.64)$ and for disgust propensity $(.56)$. In our sample the correlation between sensitivity and propensity was negligible $(r = .04)$, which attest to the relative independence of these two constructs.

### 5.2.3 Paradigm and procedure

The stimuli consisted of 36 colored photographs representing 6 emotional categories: 'Neutral objects', 'Fear', 'Core Disgust', 'Animal-Reminder (AR) Disgust', 'Erotic', and 'Neutral bodies'. Core disgust stimuli mainly portrayed humans interacting with food and body products whilst AR stimuli depicted body envelope violations (i.e., surgery, mutilation) and death. Fear stimuli mostly included humans under imminent threat. Stimuli chosen from the International Affective Pic-

ture System (Lang et al., 1999) included IAPS 3150, 3400 (AR disgust); 9320, 9300 (core disgust); 7010, 5520 (neutral); and 6550, 1300, 6350 (fear). Selection of non-IAPS pictures, which comprised the bulk of the stimuli, was done in a pre-structured process. Initially more than 200 photographs were collected by the researchers themselves. Based on characteristics agreed on a priori the research team selected 50 photographs, which were sent for further validation conducted with 40 females via an online survey `www.esurveyspro.com`. A second validation was conducted with a set of new pictures for AR disgust to reduce noise in the category of AR - due to significantly high mean on both dimensions of fear and disgust in the first validation process. The research team matched the scenes for physical features such as complexity, brightness, contrasts, ethnicity, and color. In all photographs, models were kept faceless or with minimal focus on the face.

Stimuli were presented in a block design, with each block consisting of 10 pictures representing the same category. Each photograph was presented for $1.4s$, with a $1s$ interval between consecutive stimuli. Six blocks (split by $16s$ inter-block intervals), corresponding to the six stimulus categories, were run in a pseudo-randomized sequence. Six of these functional runs were acquired for each participant, separated by $30s$ intervals, adding up to a total duration of the fMRI experiment of $1458s$. For presentation of the experimental design we used a psychtoolbox `http://psyctoolbox.org` application implemented in Matlab (Version R2009a). The stimuli were presented on a translucent screen at the end of the scanner by means of a mirror attached above the participants' head. Preceding the experiment, a training task was done inside the scanner with the aim to familiarize the participants with the procedure. Participants were instructed to look at the pictures presented and melt with their emotions. Given the passive nature of the design participants were asked to respond (i.e., press a button) to an '*' that was over-imposed on a (fixed) randomly-selected number of photographs (2 per block). These responses were recorded, but were not used in the analysis.

Post scanning, participants were accompanied to a computer room where a Visual Analogue Scale (VAS) implemented on a computer was explained to them and then they were left in their own privacy to rate the stimuli. The VAS ranging from 0 (not at all - in Dutch language 'helemaal niet') to 100 (very much - in Dutch language 'heel erg') was included to rate their subjective evaluation, on 2 dimensions: disgust, and fear. All stimuli were rated subjectively on the dimension of general arousal post hoc from an independent sample of 25 women who did not differ in other demographic data. This was done post hoc due to connotations to sexual and positive arousal for the Dutch word ('opwinding') that we used in the experiment. When the experiment was completed participants had a debriefing session with refreshments.

### 5.2.4 Image acquisition

Images were acquired on a Philips Intera 3T MR-scanner. A sense 8-channel head coil was used for radio frequency reception. A series of echo planar imaging (EPI) volumes were acquired to measure the blood oxygen level dependent (BOLD) effect, which entailed a $T2-$weighted gradient echo sequence with a repetition time (TR) of 2000 $ms$, and an echo time of 30ms. Flip angle was 70 degrees using whole-brain acquisition (matrix of size 64 $\times$ 64 voxels) and interleaved slice acquisition order, with an inter-slice gap of 0 mm and plane thickness of 3 mm. EPIs were acquired at 3 $\times$ 3 mm in-plane resolution. The (axial) images (volumes) were acquired parallel to the anterior-posterior commissure plane. In total 740 volumes were obtained per participant. A T1-weighted anatomical MRI (TR $= 9\ ms$, TE $= 3.5\ ms$, matrix of size 256 $\times$ 256) and two diffusion tensor imaging (DTI) volumes of 55 slices each of 620$ms$ duration (with scan resolution of 96 $\times$ 96, flip angle 70 degrees) were acquired after the EPI runs. The DTI measurements were not used in this manuscript.

### 5.2.5 Behavioural and self-report analysis

For the DPSS-R, two main variables namely, disgust propensity and disgust sensitivity are generated from the sum of the corresponding items provided on the scale (van Overveld et al., 2006).

### 5.2.6 fMRI pre-processing

For image pre-processing and analysis we used the Statistical Parametric Mapping software (SPM8; University College London, UK; `http://www.fil.ion.ucl.ac.uk`) implemented in Matlab 7.2 (The MathWorks Inc., `http://www.mathworks.com`). For each participant, all EPI volumes were realigned to the first volume acquired, and a mean EPI image was created. The realignment parameters were inspected and if movements exceeded 2 mm in any direction the participant was excluded from further analysis. The anatomical (T1) scan was manually co-registered to the mean EPI image, and subsequently all EPI images and the T1 image were spatially normalized to MNI (Montreal Neurological Institute) standard stereotactic space (Friston et al., 1995). Data were re-sampled to 2$\times$2$\times$2 mm ($8$mm$^3$) isotropic voxels. All volumes were smoothed with an isotropic Gaussian kernel of 8 mm full-width at half-maximum.

### 5.2.7 Image analysis

After pre-processing, analyses were performed using general linear models (GLM) at the first (subject) and second (group) level (Friston et al., 1995). Two analytic tracks were followed. First, we identified brain regions predominantly associated with core and AR disgust. Furthermore, parametric modulation was used to find BOLD responses correlating with individual disgust trait. Second, we analyzed the functional connectivity, and its interaction with disgust trait, of areas showing a clear and consistent bias towards AR and core disgust processing.

For the first strategy we computed a GLM for each participant, which included regressors for the six conditions (including conditions which are not used in any of the contrasts) and also one for the inter-run instructions, convolved with a canonical hemodynamic response function. Rotational and translational head movements were added as nuisance variables (6 covariates). For each voxel a high-pass filter (cut-off $128s$) was applied to remove low-frequency noise. A binarized version of the standard grey matter mask provided by SPM8 was used as an explicit mask. The following contrasts (contrast images) were computed: core>neutral, AR>neutral, fear>neutral. To assess hemodynamic changes at the group level (random effects) the results of these weighted contrasts were entered into a second-level flexible factorial model. We specified two factors, 'Subject' (independence 'yes'; variance 'equal') and 'Condition' (independence 'no'; variance 'equal'). The factor 'Condition' contained three levels representing the three contrast images. As covariates we entered the individual scores for DPSS-R disgust propensity and DPSS-R disgust sensitivity. We specified one main effect (Condition) and two interaction effects (propensity $\times$ Condition, sensitivity $\times$ Condition). All contrasts ([core > fear]; [AR > fear]; [core > AR]; [AR > core]), as well as the interactions with disgust trait ([core>neutral] $\times$ propensity; [AR > neutral] $\times$ propensity; [core > neutral] $\times$ sensitivity; [AR > neutral] $\times$ sensitivity), were initially tested at $p < 0.001$, uncorrected.

For the functional connectivity analysis we used psychophysiological interaction (PPI) to assess how activity in areas of interest covaries with that in other areas in the brain, as a function of the psychological context that the participants were exposed to (Friston et al., 1997). Since we aimed to distinguish between core and AR disgust, we focused on the contrasts between these two disgust stimuli. PPI seed regions were selected as follows: BOLD responses were considered to be biased to AR when they showed consistent and significant activation in AR > core and AR > fear comparisons. Likewise, Core-bias was inferred from significant and consistent activation in core > AR and core > fear comparisons. Only one area met these stringent criteria: The right ventrolateral occipitotemporal cortex (vlOT, MNI coordinates 50 -60 -8) showed a clear AR-bias. We used the AR > neutral contrast to

identify this vlOT seed area at the subject level ($p < 0.05$, uncorrected), which could be achieved in 19 out of 20 women scanned. For each selected participant, a summary time course (first eigenvariate) was extracted from the right vlOT seed region using a sphere centered on the coordinates above (sphere radius: 5mm). PPI's were calculated as the element by element product, convolved with the hemodynamic response function, of these summary time courses and a vector coding for the psychological context (AR vs. core). Subsequently, this interaction term together with the summary time course of the seed region and the vector coding for the psychological context were entered as regressors in a first level GLM, which also included the six head motion parameters as nuisance variables. The contrast images for each of these three regressors entered a random effects second level flexible-factorial model. Two factors were specified, 'Subject' (independence 'yes'; variance 'equal') and 'PPI' (independence 'no'; variance 'equal'). The factor 'PPI' had three levels representing (1) the seed region's time course, (2) the psychological vector, and (3) the interaction term (PPI). As covariates we entered the individual scores for DPSS-R disgust propensity and DPSS-R disgust sensitivity. We specified one main effect (factor 'PPI') and two interaction effects (propensity $\times$ 'PPI', sensitivity $\times$ 'PPI'). By setting the appropriate contrasts to the parameter weights, we were able to explore areas whose functional connectivity (with vlOT) was different for AR and core disgust. Critically, we sought to investigate whether this functional connectivity would correlate with individual trait disgust propensity and sensitivity. The initial threshold was set to $p < 0.001$, uncorrected, for all PPI analyses.

Clusters were considered significant if they reached $p < 0.05$, Family-wise error (FWE) corrected for multiple comparisons, either for the whole brain, or within a reduced search space representing the most consistently reported areas in disgust studies ('disgust mask'). The significance threshold was more stringent for correlations with disgust trait to reduce the risk of type I error (two traits tested, critical ($\alpha/2 = p < 0.025$). For correlations with disgust trait we also mention marginal effects ($0.025 < p < 0.05$). The 'disgust mask' (7798 voxels) comprised globus pallidus, caudate-putamen, anterior insula, amygdala, ventral occipitotemporal cortex, frontal operculum, orbitofrontal cortex. It was built using information from different sources. A bilateral frontal operculum ROI (BA44) was adopted from the SPM Anatomy toolbox (Eickhoff et al., 2005), whereas a ROI representing bilateral anterior (agranular and dysgranular) insula was hand-drawn on a brain template following the anatomical description by Nanetti (Nanetti et al., 2009). Bilateral occipitotemporal ROIs were also hand-drawn, which was guided by the results of an F-test over disgust vs. neutral contrasts of the present study (which gave very strong OT effects). This strategy did not lead to 'double dipping', because task-relevant OT activity reached significance using a threshold with

Table 5.1: Subjective evaluation for each dimension as a function of stimulus type

| Emotion | core M (SD) | AR M (SD) | Fear M (SD) | Neutral M (SD) |
|---|---|---|---|---|
| Disgust | $79.3(13.2)^{a,y}$ | $84.7(14.5)^{b,x}$ | $33.7(23.5)^{c}$ | $.60(.7)^{d}$ |
| Fear | $27.5(19.4)^{a}$ | $54.7(29.6)^{b}$ | $74.2(19.4)^{c,y}$ | $1.2(3.1)^{d}$ |

Means (M) and standard deviations (SD) of the subjective ratings for each stimulus-type (AR disgust, core disgust, fear and neutral) on 2 dimensions (disgust, fear,). Different letters in superscript (a/b/c/d) indicate significant difference between stimulus categories within a dimension. For instance, the 'a' on Core and the 'b' on AR elicitors on the first row indicates that they do differ significantly from each other on the dimension of disgust. The 2nd letter (x,y) applies to relevant comparisons across columns. For instance the 'x' of the AR on the dimension of disgust with the 'y' on Fear elicitors on the dimension of fear indicates significant difference between the two.

a FWE correction for the whole brain (Table 5.3). Caudate, putamen, amygdala, and globus pallidus ROIs were taken from the Harvard-Oxford Subcortical Atlas (`http://www.cma.mgh.harvard.edu/`). Because of substantial susceptibility artifact in the area of the orbitofrontal cortices, the OFC was not included in the mask.

## 5.3 Results

*Self-Report Measures.* Table 5.1, illustrates the subjective evaluation of each stimulus-type on the dimensions of disgust and fear. A mixed between-within subject ANOVA to assess the appraisal of categories of pictures (AR, core, fear, neutral) on 2 participants' emotional ratings (fear, and disgust) showed a significant interaction of Picture $\times$ Emotion, Wilk's $\lambda = .06,\ F(3, 17) = 85.38,\ p < .001$.

The general pattern of subjective ratings attests to the validity of the stimulus materials (see Table 5.1). To examine in more detail whether the fearful stimuli were as effective in eliciting fear as the disgust stimuli were in eliciting disgust we evaluated the relevant comparisons by means of t-tests, corrected for multiple testing: AR disgust stimuli were rated significantly higher on the dimension of disgust (M $= 84.75$, SD $= 14.53$) than of fear (M $= 54.73$, SD $= 29.62$), $t(19) = 6.23,\ p < .001,\ r = .81$ and similarly core disgust stimuli were rated significantly higher on the dimension of disgust (M $= 79.30$, SD $= 13.16$) than on fear (M $= 27.45$, SD $= 19.43$), $t(19) = 13.39,\ p < .001,\ r = .82$. The fear stimuli were rated significantly higher on fear (M $= 74.20$, SD $= 19.36$) than on disgust (M $= 33.71$, SD $= 23.52$), $t(19) = -8,43,\ p < .001,\ r = .62$; all with a large effect size.

On the other hand AR stimuli elicited stronger subjective disgust (M $= 84.74$, SD $= 14.53$) than fear stimuli elicited subjective fear (M $= 74.20$, SD $= 19.36$), $t(19) = 2.52,\ p < .05,\ r = .06$. Similarly, core stimuli elicited higher levels of disgust (M $= 79.29$, SD $= 13.16$) than fear stimuli elicited subjective fear (M $= 74.20$,

Table 5.2: Interaction between disgust domain and disgust trait

| Side region (MNI) | $k$ | $x$ | $y$ | $z$ | $Z$-score | FWE $p$ |
|---|---|---|---|---|---|---|
| Disgust Sensitivity × core disgust | | | | | | |
| L Anterior insula | 37 | $-26$ | $-28$ | 16 | 4.23 | $0.022^{*}$ |
| Disgust Sensitivity × AR disgust | | | | | | |
| L Anterior insula | 37 | $-28$ | 26 | 14 | 4.17 | $0.028^{*}$ ǂ |

Interaction between disgust domain and disgust trait. Activity in AR > neu and core > neu contrasts was correlated against self-reported disgust propensity and sensitivity, following the DPSS-R questionnaire. Significance threshold was $p < 0.025$ FWE corrected because of two traits tested (critical $\alpha/2$). $*p < 0.025$ FWE, for a disgust-relevant reduced search volume. ǂ marginally significant $(0.025 < p < 0.05)$. Clusters are listed with coordinates of the peak voxel in standard (MNI) space, and size (k voxels). The peak Z scores is given along with FWE corrected p values. No significant or expected correlations were found with disgust propensity. MNI, Montreal Neurological Institute.

SD= 19.36), $t(19) = 1.31$ $p < .20$ $(\alpha/6 = .03)$, $r = .01$. AR disgust stimuli (M = 84.74, SD = 14.53) differed significantly from core disgust stimuli (M = 79.29, SD = 13.16), $t(19) = -2.28$, $p < .03$ $(\alpha/6 = .01)$, $r = .05$, in that the category of AR stimuli elicited higher level of subjective disgust compared to core disgust elicitors. On the dimension of fear, AR stimuli (M = 54.73, SD = 29.62) were rated as more fearful than core disgust stimuli (M = 27.45, SD = 19.43), $t(19) = -7.05$, $p < .001$, $r = .50$.

To test the alleged relationships between both indices of trait and state disgust we computed bivariate Pearson correlations between DPSS (propensity and sensitivity) on the one hand, and the subjective disgust elicited by both types of disgusting stimuli on the other. Supporting the validity of the DPSS, and in line with the constructs of propensity there were positive correlations with the experienced intensity of disgust for both core $(r = .26)$ and AR $(r = .45)$ disgust elicitors. Although only for the latter the correlation reached the conventional level of significance. Also in line with the construct of sensitivity there were no correlations with sensitivity and core disgust elicitors $(r = .01)$ and neither with sensitivity and AR disgust elicitors $(r = .01)$.

*Brain areas showing interactions between Disgust Domain and Individual Disgust Trait.* The only significant interaction was observed in the dorsal-most part of the left anterior insula (Figure 5.1, Table 5.2). The specific nature of this interaction was that both when subjects watched AR and core stimuli, their activity in this part of the insula was modulated by disgust sensitivity, but not propensity. In the right counterpart this effect was only marginal. No significant or meaningful negative correlations were identified.

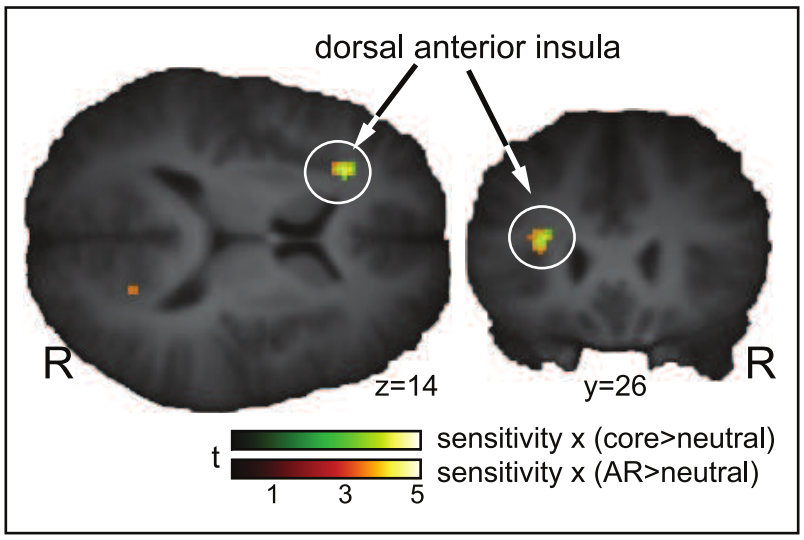


Figure 5.1: Correlation between BOLD activity induced by AR- and core disgust elicitors and self-reported disgust sensitivity. Note that correlates of disgust sensitivity occur in the same area of the left anterior dorsal anterior insula irrespective of disgust domain

*Areas Predominantly Associated with Core and AR Disgust.* For core > AR, significant clusters were found in the posterior part of the middle temporal gyrus (pMTG), bilaterally, and in the most-dorsal part of the posterior cingulate cortex. For the reverse contrast, AR > core, significant clusters were found in the left lingual gyrus, the posterior part of the right inferior temporal gyrus (ventrolateral occipitotemporal cortex, vlOT), the right middle occipital gyrus, the right postcentral gyrus extending into supramarginal gyrus, and bilaterally in the cerebellar hemisphere.

To further specify the disgust-related brain responses, we included Fear as an aversive and arousing, but not disgusting control category. For core > fear significant clusters were found in bilateral fusiform gyrus and the right ventral pallidum (which spread to include the right amygdala, and contra-lateral ventral pallidum). For AR > fear, results largely resembled the AR > core comparison. Significant clusters were present in the left lingual gyrus, vlOT, inferior parietal lobule, and inferior frontal gyrus (frontal operculum) corresponding to the location of the premotor cortex in the right hemisphere. All effects are listed in Table 5.3.

Table 5.3: Areas predominantly associated with AR and core disgust processing

| Side region (MNI) | $k$ | $x$ | $y$ | $z$ | $Z$-score | FWE $p$ |
|---|---|---|---|---|---|---|
| *core disgust > AR disgust* | | | | | | |
| L Middle temporal gyrus | 1159 | −58 | -5410 | 4.91 | 0.000 | |
| R Middle temporal gyrus | 826 | 58 | -4010 | 4.71 | 0.000 | |
| L Posterior cingulate cortex | 906 | -12 | -42 48 | 4.18 | 0.000 | |
| *core disgust > fear* | | | | | | |
| L Fusiform gyrus | 1273 | -28 | -46 | -10 | 5.89 | 0.000 |
| R Ventral pallidum / amygdala | 1187 | 18 | 0 | -12 | 4.110 | 0.000 |
| R Fusiform gyrus | 1078 | 28 | -48 | -10 | 5.360 | 0.000 |
| *AR disgust > core disgust* | | | | | | |
| L Lingual gyrus / cerebellum | 1933 | -10 | -92 | -4 | 5.760 | 0.000 |
| R Postcentral gyrus | 462 | 42 | -30 | 40 | 4.110 | 0.002 |
| **R Inf. temporal gyrus (vlOT)** | **262** | **50** | **-60** | **-84.66** | **0.029** | |
| R Middle occipital gyrus | 236 | 36 | -788 | 4.48 | 0.049 | |
| *AR disgust > fear* | | | | | | |
| L Lingual gyrus / inf. temporal gyrus | 5059 | -8 | -92 | -4 | 6.550 | 0.000 |
| **R Inf. temporal gyrus (vlOT)** | **1130** | **52** | **-58** | **-8** | **5.670** | **0.000** |
| R Middle occipital gyrus | 478 | 36 | -8214 | 5.89 | 0.002 | |
| R Superior parietal lobule | 1549 | 24 | -64 | 56 | 4.760 | 0.000 |
| R Inf. frontal gyrus (frontal operculum) | 254 | 52 | 10 | 28 | 4.440 | 0.032 |

Core and AR were contrasted against each other and against fear. Listed clusters reached $p < 0.05$, FWE corrected. Clusters are listed with coordinates of the peak voxel in standard (MNI) space, and size (k voxels). The peak Z scores is given along with FWE corrected p values. MNI, Montreal Neurological Institute; R, right hemisphere; vlOT, ventrolateral occipitotemporal cortex; Z, Z-value; Inf., Inferior.

*Right vlOT functional connectivity.* No area correlated stronger with the right vlOT during AR disgust relative to core (Table 5.4). However, we identified a network of areas whose functional connectivity with the right vlOT was weaker during AR than during core disgust. Clusters where the strength of this correlation was significant were the left thalamus (extending into the striatum), anterior (aMCC) and posterior (pMCC) parts of the middle cingulate cortex, the right superior frontal gyrus (dorsolateral prefrontal cortex, dlPFC). Marginal effects were observed in the right superior medial gyrus (dorsomedial prefrontal cortex, dmPFC) and right parietal operculum. At least for part of the cingulate and PFC, we could establish (via additional PPI's with the baseline) that the weaker coupling with the right vlOT during AR relative to core was due to decreased coupling during AR relative to baseline, which was unaltered for core disgust.

Table 5.4: Right vlOT functional connectivity (PPI) of core relative to AR disgust

| Side region (MNI) | $k$ | $x$ | $y$ | $z$ | $Z$-score | FWE $p$ |
|---|---|---|---|---|---|---|
| *Core disgust > AR disgust* | | | | | | |
| L Thalamus / putamen / globus pallidus | 586 | -14 | -8 | 20 | 4.41 | 0.000 |
| R/L Middle cingulate cortex, ant (aMCC) | 439 | 2 | 28 | 22 | 4.29 | 0.002 |
| R/L Middle cingulate cortex, pos (pMCC) | 340 | 8 | -18 | 40 | 3.71 | 0.007 |
| R Superior frontal gyrus (dlPFC) | 318 | 22 | 38 | 36 | 4.14 | 0.010 |
| R Rolandic operculum | 230 | 60 | -20 | 18 | 3.94 | 0.035 |
| R Superior medial gyrus (mPFC) | 228 | 6 | 62 | 8 | 3.53 | 0.036 |

Functional connectivity of right vlOT. The psychophysiological interaction (ppi) of the right vlOT with the rest of the brain was calculated, with the psychological context vector set to AR > core. No area correlated stronger with the right vlOT during AR relative to core disgust. Clusters are listed with appropriate anatomical label, size ($k$ voxels), and peak voxel location in MNI coordinates (relative to anterior commissure, AC). Negative sign for $x$, $y$, and $z$ indicates left, posterior, and ventral to AC, respectively. AR, animal-reminder disgust elicitors; core, core disgust elicitors; ant, anterior; aMCC, mid cingulate cortex; dlPFC, dorsolateral prefrontal cortex; L, left hemisphere; MNI, Montreal Neurological Institute; mPFC; medial prefrontal cortex; R, right hemisphere; sup, superior; vlOT; ventrolateral occipitotemporal cortex: $Z$, $Z$-value.

Trait disgust propensity, but not sensitivity, modulated correlations with the right vlOT, and this modulation was stronger during AR than during core disgust (Figure 5.2, Table 5.5). This effect was significant for the aMCC, and marginal for the right inferior frontal gyrus (frontal operculum, ventral premotor cortex) and the left anterior insula.

Table 5.5: Right vlOT functional connectivity modulated by disgust trait (PPI)

| Side region (MNI) | $k$ | $x$ | $y$ | $z$ | $Z$-score | FWE $p$ |
|---|---|---|---|---|---|---|
| *Disgust Propensity: AR > core* | | | | | | |
| L aMCC | 570 | $-4$ | 24 | 30 | 4.35 | 0.000 |
| R Inferior frontal gyrus (frontal operculum) | 198 | 60 | 14 | 6 | 4.11 | $0.038^{*}$ ǂ |
| L Anterior insula | 71 | $-32$ | 12 | 14 | 4.06 | $0.046^{*}$ ǂ |

Right vlOT functional connectivity modulated by disgust trait. The psychophysiological interaction (PPI) of the right vlOT with the rest of the brain was calculated, with the psychological vector set to $AR > core$. Modulation by disgust propensity was calculated by calling the interaction term (PPI $\times$ disgust propensity) in the flexible factorial model. Significance threshold was $p < 0.025$ FWE corrected because of two traits tested (critical $\times/2$). $*p < 0.025$ FWE, for a disgust-relevant reduced search volume. ǂmarginally significant $(0.025 < p < 0.05)$. Clusters are listed with coordinates of the peak voxel in standard (MNI) space, and size ($k$ voxels). The peak $Z$ scores is given along with FWE corrected p values. Disgust sensitivity did not modulate right vlOT connectivity. aMCC, anterior part of middle cingulate cortex; MNI, Montreal Neurological Institute; R, right hemisphere; vlOT, ventrolateral occipitotemporal cortex; $Z$, $Z$-value. ǂmarginally significant $(0.025 < p < 0.05)$. Clusters are listed with coordinates of the peak voxel in standard (MNI) space, and size ($k$ voxels). The peak $Z$ scores is given along with FWE corrected p values. Disgust sensitivity did not modulate right vlOT connectivity. aMCC, anterior part of middle cingulate cortex; MNI, Montreal Neurological Institute; R, right hemisphere; vlOT, ventrolateral occipitotemporal cortex; $Z$, $Z$-value.

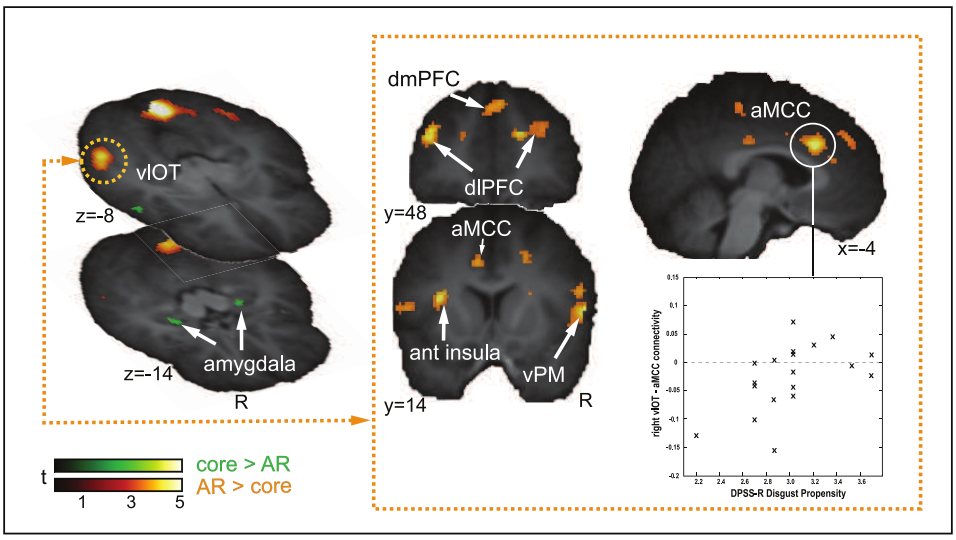


Figure 5.2: Frontal-posterior connectivity is modulated by self-reported disgust propensity as a function of disgust domain. On the left side, areas are shown that preferentially responded to AR (orange shading). The amygdala on both sides showed a statistically non-significant preferential response to core disgust stimuli (green). Because right vlOT activated significantly relative to fear and core disgust (Table 5.3), AR bias was inferred and this area was selected as seed region for PPI analysis. Functional connectivity of the right vlOT (right half of the figure) correlated with individual disgust propensity in a number of areas, and this modulation was stronger under conditions of AR. In the bottom right, individual vlOT-aMCC functional connectivity is plotted against individual disgust propensity, which illustrates that in all likelihood the AR-disgust propensity interaction effect was driven by women with low disgust propensity who had weak functional connectivity with the right vlOT. aMCC, middle cingulate cortex, anterior part; dlPFC, dorsolateral prefrontal cortex; dmPFC, dorsomedial prefrontal cortex; vlOT, ventrolateral occipitotemporal cortex; vPM, ventral premotor cortex. SPM's threshold at $p < 0.001$, uncorrected, for display purposes.

## 5.4 Discussion

In the present study, we used brain imaging to shed more light on the complex nature of disgust, a complexity that has recently also gained interest as a relevant factor in the origin and maintenance of psychopathology (Olatunji et al., 2008). Specifically, we aimed to find brain mechanisms associated with distinct disgust domains (core, AR) and traits (propensity, sensitivity), as well as the interaction between them. A series of behavioural and psychometric studies already showed that core and AR disgust represent distinct classes of disgust elicitors (van Overveld et al., 2009). Here, we present evidence that core and AR can also be discerned at the

brain network level. The right ventrolateral occipitotemporal cortex (vlOT), which responded most robustly to visual AR, showed disgust domain-dependent functional coupling with a network comprising thalamus, anterior (aMCC) and posterior (pMCC) middle cingulate cortex, and dorsal prefrontal areas. Disgust propensity, but not sensitivity, modulated the strength of vlOT coupling, and this modulation was strongest during AR. Specifically, this modulation was found to be strongest for the vlOT-aMCC coupling, which is interesting in the light of behavioural flexibility and other functions ascribed to the aMCC. The same domain-trait interaction revealed coupling with anterior insula and ventral premotor cortex (areas known to play a pivotal role in disgust processing), though this modulation was found to be only marginally significant $(0.025 < p < 0.05)$. On the other hand, disgust sensitivity modulated left anterior insula activity irrespective of domain, and did not affect functional connectivity. These results not only support the idea that AR and core disgust are fundamentally distinct (Haidt et al., 1994), they also stress the significance of disgust traits as modulators of the disgust response.

The anterior insula generally responds to elicitors of both types of disgust (Heining et al., 2003; Schienle et al., 2006), and this response tracks with the severity of both individual traits (Calder et al., 2007; Schienle, Schafer, Walter, Stark and Vaitl, 2005) and experienced disgust (Harrison et al., 2010). We concur with these findings, showing that left dorsal anterior insula activity correlated with individual disgust sensitivity, but not propensity (Figure 5.1). These findings are also in line with the suggestion that the dorsal anterior insula processes disgust experience (Harrison et al., 2010) rather than recognition (of facial disgust expressions), which preferentially recruits ventral anterior insula (Jabbi et al., 2008; Phillips et al., 1998; von dem Hagen et al., 2009).

Recently, evidence was presented to argue that the psychophysiological origins of AR and core disgust responses are fundamentally distinct. Specifically, the left anterior insula showed conjugated activity between experienced AR disgust and AR-induced reduction of parasympathetic heart activity ('dizziness'), whereas core-induced dysregulated gastric muscular activity ('stomach turning') and experienced core disgust shared activity in the right anterior insula (Harrison et al., 2010). We followed a different approach, exploiting individual differences in disgust trait (which is likely to be connected to higher-order cortical functions) to further set apart AR and core disgust at the level of brain networks.

As mentioned in the introduction of this chapter, previous studies comparing core and AR-like disgust elicitors have found neocortical responses generally inclined to AR and restricted to posterior neocortical areas like the occipitotemporal cortex (Sarlo et al., 2005), and inferior (Schienle et al., 2006) and superior parietal lobule (Wright et al., 2004). We identified a cluster in the right ventrolateral oc-

cipitotemporal (vlOT) cortex that activated more prominently during exposure to AR than to core or fear stimuli, which made us conclude that this area exhibited 'AR-specific activity'. The finding that subjective arousal was not significantly different between AR and core, argues against the suggestion that occipitotemporal activity reflects emotion-induced arousal and, therefore, does not carry a specific emotional signature (Mourao-Miranda et al., 2003; Wright et al., 2004). The location of the vlOT cluster corresponds with that of the extrastriate and fusiform body areas (EBA/FBA), which contain neurons that preferentially respond to body parts (Downing et al., 2001; Orlov et al., 2010), and bodily shapes, but also body scheme distortions (Wagner et al., 2003; Uher et al., 2005).

The only systematic bodily difference between stimuli was that distortions were absent in all stimuli except AR - where they were abundant (injury, mutilation). Enhanced vlOT responses during AR may therefore reflect the severe violation of the general body scheme that is characteristic of mutilated bodies or body envelope injury. If the vlOT indeed contributes to decoding of the danger message conveyed by body injury (Pessoa, 2005), it seems reasonable to propose that the vlOT constitutes a cortical gateway of major interest in the context of AR.

Functional coupling of the right vlOT with other parts of the brain was driven not only by disgust domain but also by disgust trait. Specifically, individual disgust propensity, but not sensitivity, modulated the psychophysiological interaction - coupling with the right vlOT being stronger during AR than core disgust - especially in the anterior part of the middle cingulate cortex (aMCC). For left dorsal anterior insula and the interior frontal gyrus (ventral premotor cortex), functional connectivity with the right vlOT was only revealed when disgust propensity was taken into account. Though less prominent than the modulation of vlOT-aMCC connectivity, this finding is capturing from the perspective that the vPM, insula, and vlOT are part of a putative network implicated in social cognition, action imitation, and empathic ability (Keysers and Gazzola, 2010; Zaki et al., 2010; Caspers et al., 2010).

Disgust propensity is likely to depend on cognitive resources more than disgust sensitivity. It is interesting that individual disgust propensity, but not sensitivity, modulated functional connectivity between right vlOT and aMCC, an area heavily associated with behavioural flexibility (Zaki et al., 2010; Bush et al., 2002; Georgiadis et al., 2010). During certain expectation of a negative stimulus, for example, the aMCC gets activated and aMCC-occipitotemporal coupling gains strength (Herwig et al., 2007; Onoda et al., 2008). This could serve to prevent a motor response, like withdrawal or avoidance, which does not meet environmental demands.

Based on the network of areas communicating with the right vlOT, and recalling that those high in disgust propensity rated AR stimuli as more disgusting, what could be the mechanism that determines AR disgust? A recent study used a re-

sponse conflict design with both contextual and nonverbal (bodily) information, and demonstrated that individuals who relied more on nonverbal cues to resolve a conflict not only activated the vlOT more strongly, but also had stronger positive functional coupling between aMCC and ventral premotor cortex (Zaki et al., 2010).

Though not an exact copy of our result, it does present a remarkably similar network that correlates with cognitive decisions based on interpretation of bodily information, and such interpretations may be important to the effectiveness of AR stimuli. When we plotted the strongest functional connection, vlOT-aMCC, we made an important observation. It appeared that women with low disgust propensity were driving the correlation, showing weak vlOT-aMCC functional connectivity during AR relative to core disgust (Figure 5.2). This may have been due to AR-induced 'vlOT uncoupling' in these women. First, the correlation between right vlOT and aMCC was positive across all conditions (result not shown), so we assume right vlOT to exhibit positive connectivity both during AR and core disgust. Second, across subjects, this coupling was reduced during AR, relative to baseline, whereas during core disgust it was similar to baseline (see result section). This suggests that AR - and not core - was the condition driving the observed modulation of vlOT connectivity by disgust propensity.

Assuming other functional connections were modulated in a similar way, but in appreciation of the fact that this modulation was not equally prominent for all areas (Table 5.5), one might take the liberty to argue that individuals with low disgust propensity (who report infrequent disgust responses) are 'safeguarded' against AR-disgust. Weaker coupling between vlOT and ventral premotor cortex could indicate different interpretation of this particular kind of bodily information. In turn, this would less likely necessitate enhanced behavioural flexibility (e.g., to adhere to the experiment), represented by reduced coupling with aMCC. These individuals could be less liable to experience disgust, which is supported by reduced coupling with the dorsal anterior insula, an area strongly related to disgust experience (Harrison et al., 2010).

No area could be specifically linked to core disgust processing, at least not according to the criteria used here. An interesting observation is that the amygdala and dorsally-adjacent ventral pallidum exhibited a subsignificant (i.e. significant for core > fear, but only a trend for core > AR) preference for core disgust stimuli (see Figure 5.2). This supports findings that the amygdala responds strongly to disgusting tastes and smells (Zald et al., 2002; Zald and Pardo, 1997), but not to higher-order moral disgust (Moll et al., 2005; Schaich Borg et al., 2008). Together with evidence that the posterior part of ventral pallidum processes food-related disgust (Calder et al., 2007), a more primal route in the brain for contamination-related input may be suggested. This may represent yet another neural distinction between

AR and core disgust, even when the present results are not sufficiently consistent to fully resolve this issue.

Several comments are in order with respect to the current study: First, in this study we preferred the DPSS-R over content-dependent trait disgust measures, as it prevents artificial relationships between the measure of trait disgust and actual disgust responding during the experiment due to content overlap of stimuli (van Overveld et al., 2010). Moreover, it is the only instrument available that differentiates between disgust propensity and disgust sensitivity. Attesting to the relevance of differentiating between both disgust traits, the correlation between both subscales approached zero. Furthermore, sustaining both the validity and reliability of the DPSS-R, the subscales showed a meaningful pattern with state disgust showing that only disgust propensity was associated with the level of subjective disgust that was elicited in the present experiment. It should be acknowledged, however, that the internal consistency of the DPSS subscales for our sample was relatively low (especially for propensity), which might have reduced the sensitivity of our study to detect relevant interactions between trait disgust and particular patterns of disgust-related brain activity. In addition, it points to the possibility that the trait-brain interactions that were evident in this study may only depend on particular aspects of the propensity and sensitivity constructs.

Secondly, core and AR differed in their potency to elicit fear; AR stimuli were rated as more fearful than core disgust stimuli. Thus where we find differences between AR and core at the central level, this could, at least partially, be due to fear-related processing. Yet, fear may be an intrinsic component of the emotions that are elicited by stimuli generally considered representatives of core, and particularly AR disgust. Note that imprecise labelling of emotional feelings is not uncommon for fear and disgust (Woody and Teachman, 2002). If indeed fear is an intrinsic component of the emotional feelings that are elicited particularly by AR disgust stimuli (compared to core disgust) it is impossible to control for that. Perhaps it is also relevant to note that fear and disgust are no properties of the stimulus materials per se. Stimuli might elicit fear because they relate to impending harm, but also because they may give rise to contamination. Hence in the present context it may not be very helpful to think in terms of pure emotional feelings - rather it seems more worthwhile to use proper stimuli well representative of the categories of interest.

The final considerations concern the brain imaging data. PPI is not a measure of effective connectivity (Friston et al., 1997), making inferences about causality impossible. Moreover, the current implementation of PPI in SPM does not allow one to check the sign of the correlation between regions within a task. In that respect, claims about weaker connectivity between right vlOT and other areas are somewhat speculative. In this study we were specifically interested in two distinct disgust

traits, but we had no a priori hypothesis about how their distinctiveness would affect brain effects and connectivity patterns. Some of the effects (indicated in Table 5.2 and Table 5.5) should therefore be approached with more caution. In the light of current interpretations of the results, we further acknowledge that we did not gather subjective information on for example, social cognition, or reliance on bodily information. Finally, due to the homogeneity of our participants in terms of gender, age, education, menstrual phase, and no sexual complaints, generalizability may be restricted.

Taken together, the present findings advance our understanding of disgust by showing that AR and core disgust can be distinguished at the brain network level. Specifically, functional connectivity in a frontal-posterior network was modulated by trait disgust propensity, and this seemed to be driven by the AR condition. It is possible that this finding reflects the different attitudes and emotional responses (disgust, fascination, enjoyment) people may show towards AR.

# Chapter 6

# Subcortical BOLD responses during visual sexual stimulation vary as a function of implicit porn associations in women

**Abstract**

*Life-time experiences shape people's attitudes towards sexual stimuli. Visual sexual stimulation (VSS), for instance, may be perceived as pleasurable by some, but as disgusting or ambiguous by others. VSS depicting explicit penile-vaginal penetration (PEN) is relevant in this respect, because the act of penetration is a core sexual activity. In this study, 20 women without sexual complaints participated. We used functional magnetic resonance imaging (fMRI) and a single-target implicit association task (stIAT) to investigate how brain responses to PEN were modulated by the initial associations in memory (PEN-'hot versus PEN-disgust) with such hardcore pornographic stimuli. Many brain areas responded to PEN in the same way they responded to disgust stimuli, and PEN-induced brain activity was prone to modulation by subjective disgust ratings towards PEN stimuli. The relative implicit PEN-disgust (relative to PEN-'hot') associations exclusively modulated PEN-induced brain responses: Comparatively negative (PEN-disgust) implicit associations with pornography predicted the strongest PEN-related responses in the basal forebrain (including nucleus accumbens and bed nucleus of stria terminalis), midbrain, and amygdala. Since these areas are often implicated in visual sexual processing, the present findings should be taken as a warning: apparently their involvement may also indicate a negative or ambivalent attitude towards sexual stimuli.*

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## 6.1 Introduction

Visual sexual stimulation (VSS) is a powerful route into the brain's core emotional circuitry. A recent review of VSS brain imaging experiments led to the identification of a sexual interest or saliency network that seems to primarily support fast and early processing of VSS, that is, before objective or subjective sexual arousal become obvious (Georgiadis and Kringelbach, 2012). The core elements of this 'early' sexual network are amygdala, ventral striatum, anterior insula, posterior orbitofrontal cortex, and perigenual anterior cingulate cortex (Childress et al., 2008; Oei et al., 2012; Gillath and Canterberry, 2012; Hamann et al., 2004; Sescousse et al., 2010; Ponseti et al., 2006; Ferretti et al., 2005; Safron et al., 2007; Walter et al., 2008). In men and women alike, activity of (components of) the sexual saliency network varies as a function of expectation, contingency awareness (Klucken et al., 2009), prediction error, and hedonic value (Sescousse et al., 2010), which is at least suggestive of the possibility that prior experiences with sexual stimuli play an important modulatory role in shaping VSS-induced brain responses (Georgiadis and Kringelbach, 2012).

Sexual activity is under strong social control, and that expressions of sexuality (e.g., responses to VSS) are at least partly determined by social beliefs and group norms. Thus, one might expect people to vary in their attitude towards sex, including the way they perceive and respond to VSS. The observation that people may have both negative as well as positive affective judgments about VSS should therefore not be surprising (Laan and Everaerd, 1995). Even though positive affect generally facilitates subjectively reported sexual arousal (Janssen et al., 2000; Laan and Everaerd, 1995; Heiman et al., 2011), people sometimes report ambivalent emotions (that is, co-occurring negative and positive affective judgments) towards VSS, and this ambivalence does not exclude the occurrence of subjective sexual arousal (Peterson and Janssen, 2007). For example, when experiencing pleasure by watching pornography, people may at the same time feel guilty or disgusted with their behaviour (Mosher and Macian, 1994). Thus far, it is largely unclear whether the VSS-induced brain activation is most closely associated with the more positive or with the more negative components of people's subjective evaluation of VSS. Germane to this, previous brain imaging studies on the relationship between sex and disgust have shown substantial overlap in VSS- and disgust-induced activation maps (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). This overlap is seen in occipitotemporal cortex, superior parietal lobule, amygdala, ventral pallidum, and thalamus, and is generally attributed to general arousal and/or attention phenomena, (Walter et al., 2008). Yet, it may also reflect that the VSS elicited negative affective associations. Therefore, in the present study we included the subjective VSS evalu-

ations and investigated to what extent individual variability in VSS-induced brain activity could be explained by the participants' positive and negative appraisals.

Research on people's attitudes toward VSS up until now predominantly focused on explicit attitudes that can be indexed by self-report measures. However, current 'dual process models' emphasize the importance to differentiate between these explicit (deliberate) affective evaluations and more automatic (implicit) associations (Gawronski and Bodenhausen, 2006). Implicit attitudes are assumed to follow from the initial activation of simple associations in memory and to be involved in the more spontaneous, reflexive type of behaviour (like genital responses in the case of sex); whereas, the explicit evaluations are thought to be the outcome of validation processes, and to be more closely linked to reflective behaviour. Interestingly, people's explicit reports are not necessarily concordant with their implicit associations. In the case of VSS it may be that autonomous genital responses occur when negative affective evaluations (e.g., aversion) are reported, and this specific discordance is most typical of women (Laan et al., 1994; Laan and Everaerd, 1995; Spiering et al., 2003). It is unknown whether VSS first (automatically) elicits positive affective associations followed by a negative appraisal, or whether the reverse order is true. Alternatively, both attitudes may initially act in concert, and discordance develops in the validation process.

Direct, automatic, associations may be indexed by performance measures, such as the Implicit Association Task (IAT). Previously, the IAT has been used to test participants' implicit attitudes toward PEN (hardcore pornography focusing on penile-vaginal penetration) and revealed a relatively strong automatic association between PEN and disgust in women with penetration disorder [DSM-5, code: N-04] (Borg et al., 2010). This is interesting, because the act of penetration lies at the very core of sexual activity, and therefore might be conceived to carry considerable sexual incentive value. However, VSS including PEN may also be perceived as immoral and degrading to women (McKenzie-Mohr and Zanna, 1990; Padgett et al., 1989). Indeed, women had more negative sexual implicit associations than their male counterparts (as indicated by the IAT), especially when the words used in the task were of a more socially unacceptable nature (Geer and Robertson, 2005).

Our main and major aim was therefore to identify where in the brain, areas are particularly sensitive to individual variations in implicit PEN-disgust relative to PEN-'hot' associations. Such areas might conceivably be relevant in negotiating the automatic sexual pleasure or disgust response towards VSS, at least when it comes to PEN stimuli. We expect that individual IAT scores are most likely to modulate subcortical activity. First, this would be in line with a previous study connecting fMRI and IAT, albeit in a completely different emotional context (Phelps et al., 2000). Second, deep brain areas are known to be most critical in fast, automatic processing

of VSS (Oei et al., 2012; Childress et al., 2008). In addition, any cortical area known to respond robustly to briefly presented VSS (anterior insula, orbitofrontal cortex, perigenual anterior cingulate cortex) might be conceived to undergo such modulation.

All in all, the present study was designed to comprehensively asses how explicit and implicit attitudes toward PEN stimuli (a putative VSS subcategory) relate to PEN-induced brain activity.

## 6.2 Materials and methods

### 6.2.1 Participants

Twenty-one healthy women with a mean age of 22 years (SD $= 2.1$) participated in this study against modest reimbursement. One volunteer was excluded from evaluation because of excessive head motion and poor compliance. All participants provided written informed consent. The experiment was approved by the local Medical Ethical Committee, and all procedures were conducted in accordance with its standard.

The participants were scanned in the first half of their menstrual cycle and never during menstruation. From our sample 20% did not make use any form of contraceptives, whilst 80% used oral contraceptives. Participants had to be in a heterosexual relationship for a minimum of 6 months to be eligible for participation. In this study, 35% reported being in a relationship of $>$ 2 year-long, 20% in a $>$ 1 year $<$ 2 year-long relationship, and 45% of our sample were in a $<$ 1 year-long relationship. Women with a history of neurological or psychiatric problems, severe head trauma, drug abuse, and/or prescribed psychotropic medications were excluded. All participants reported moderate alcohol and nicotine consumption at most. Participants self-reported as healthy controls in an on-going study about cognitive processes in women with sexual pain disorders. They were then screened over the phone and only those who have experienced sexual intercourse, and were free of sexual complaints could participate. Apart from two participants who were predominantly left handed, all participants were exclusively right handed according to the Edinburgh Handedness Inventory (Oldfield, 1971). Participants were exclusively (75%) or predominantly (25%) heterosexual based on the Kinsey's Heterosexual-Homosexual Rating Scale (Kinsey et al., 2003).

### 6.2.2 fMRI paradigm and procedure

For the broader study on sexual pain disorders that we are currently conducting in our lab the stimuli consisted of 36 colored photographs representing 6 emotional categories: 'Neutral objects' (NEU); 'Fear'; Core disgust (DIS) (e.g., a person vomiting, faeces); Animal-Reminder disgust (e.g., mutilation); 'Sexual Penetration' (PEN), and 'Neutral bodies' (BOD). For this particular study we focused on PEN, NEU, BOD and DIS stimuli. PEN depicted hardcore coital interaction, with explicit focus on penile-vaginal penetration. The contextual information was limited and faces were not shown. BOD comprised interacting, minimally clothed male and female bodies without sexual connotations (e.g., sports). DIS was used because it represents the most primal disgust category (which compares to the primal nature of PEN) and because it induces similar arousal as PEN, but with negative valence (Rozin et al., 1999; Borg and de Jong, 2012). Also for DIS and BOD, faces were not shown. Stimuli chosen from the International Affective Picture System (IAPS) (Lang et al., 1999) included: 7010, 5520 (NEU). Selection of non-IAPS pictures was done in a pre-structured process. Initially more than 200 photographs were collected by the researchers. Based on characteristics agreed on a priori the research team selected 50 photographs. These characteristics included: no focus on faces; Caucasian heterosexual couples; easily recognizable features; very limited context. Selected pictures were then sent for further validation conducted with 40 females via an online survey (`www.esurveyspro.com`). This was done over and above the researchers' team selection to make sure that each stimulus from the relevant category elicited significantly more the intended emotion than the other categories. For example the DIS stimuli had to elicit significantly more disgust than the other categories. The research team matched the scenes for physical features such as complexity, brightness, contrasts, and color. Apart from content-based validation, the stimuli were also validated with respect to color. No significant differences were found on the RBG color distribution ($p > .2$).

Stimuli were presented in a block design, with each block consisting of 10 pictures representing the same category. Each photograph was presented for $1.4s$, with a 1s interval between consecutive stimuli. Six blocks (split by $16s$ inter-block intervals), corresponding to the six stimulus categories, were run in a pseudo-randomized sequence. Six of these functional runs were acquired for each participant, separated by $30s$ intervals, adding up to a total duration of the fMRI experiment of $1458s$. A psychtoolbox (`http://psyctoolbox.org`) application was developed for presentation of the experimental design.

Preceding the experiment a training task was done inside the scanner. Participants were instructed to look at the pictures presented and melt with their emo-

tions. Given the passive nature of the design participants were asked to respond (i.e., press a button) to an '$\star$' that was over-imposed on a (fixed) randomly-selected number of photographs. These responses were recorded, but were not used in the analysis. Post scanning, participants conducted a single-target (st) IAT and a Visual Analogue Scale (VAS), followed by a debriefing session.

The stIAT is a computerized reaction time (RT) task that measures to what extent a single-target category is associated with two attribute categories. In this study, the stIAT was used to measure the relative automatic associations with PEN. Pictures with PEN content formed the (single) target in the task, and the attributes consisted of negative/disgust vs. positive/'hot' words. Participants were instructed to categorize words of the three categories that appeared in the middle of a computer screen by means of two response buttons. In one test phase 'sex' and 'disgust' were mapped on a single response key, and 'hot' on the other. The idea is that the task becomes easier when two pairings that are strongly associated, share the same response key. Consequently, the difference in RT between both test phases is assumed to reflect whether sex is associated more strongly with either attribute category. RTs were analysed using the now widely used $D_4$-measure scoring algorithm (Greenwald et al., 2003). In this paper, we report the $D_4$-measure (Table 6.1). Here, negative stIAT effects (i.e., negative $D_4$-measure) indicate relatively fast responses when sex shared the response key with disgust. Hence, in this stIAT, negative $D_4$-measure means stronger PEN-disgust associations (see Supplementary material). We included VASs to also rate the subjective appraisal of all the stimuli presented on the dimensions of disgust, pleasure and arousal. The VASs ranged from zero (not at all) to 100 (very much). All stimuli were rated subjectively on the dimension of general arousal post hoc from an independent sample of 25 women that did not differ in other demographic data. This was done post hoc due to connotations to sexual and positive arousal for the Dutch word ('opwinding') that we used in the experiment (Table 6.2).

### 6.2.3 Functional magnetic resonance imaging

#### Image acquisition

Images were acquired on a Philips Intera 3T MR-scanner. A sense 8-channel head coil was used for radio frequency reception. A series of echo planar imaging (EPI) volumes were acquired to measure the blood oxygen level dependent (BOLD) effect, which entailed a T2$\times$weighted gradient echo sequence with a repetition time (TR) of 2000$ms$, and an echo time of 30$ms$. Flip angle was 70 degrees using whole-brain acquisition (matrix size $64 \times 64$ voxels) and interleaved slice acquisition order, with an inter-slice gap of 0 mm and plane thickness of 3mm. EPIs were acquired at $3 \times$

Table 6.1: Single-target implicit association task

| | | Participants M (SD) |
|---|---|---|
| RT | RT PEN-disgust (Negative) | 638 (75) |
| | RT PEN-'hot' (Positive) | 628 (59) |
| $D_4$ | stIAT | .03 (.79) |

Legend: RT, Reaction time. RT PEN-Disgust is the reaction time with the pairings PEN-disgust which here are negative associations, and RT PEN-Hot is the reaction time for the pairing PEN-Hot, which here are positive associations. Overall, the RTs for both pairings were very similar within this cohort (Borg et., 2010). M=mean, SD=standard deviation. D4 is the IAT effect, typically referred to as the D-measure (see Supplementary material for a detailed description, see Appendix 6.A). stIAT here refers to the single target implicit association task towards penetration (PEN) stimuli as the target

3mm in-plane resolution. The (axial) images (volumes) were acquired parallel to the anterior-posterior commissure plane. In total 740 volumes were obtained per participant. A T1-weighted anatomical MRI (TR = 9ms, TE = 3.5$ms$, matrix of size $256\times256$) and two diffusion tensor imaging (DTI) volumes of 55 slices each of 620$ms$ duration (with scan resolution of $96 \times 96$, flip angle 70 degrees) were acquired after the EPI runs. The DTI measurements were not used in this manuscript.

**Image pre-processing**

For image pre-processing and analysis we used Statistical Parametric Mapping software (SPM8; University College London, UK; `http://www.fil.ion.ucl.ac.uk`). For each participant, all EPI volumes were realigned to the first volume acquired, and a mean EPI image was created. The realignment parameters were inspected and if movements exceeded 2 mm in any direction the participant was excluded from further analysis. The anatomical (T1) scan was manually co-registered to the mean EPI image, and subsequently all EPI images and the T1 image were spatially normalized to MNI (Montreal Neurological Institute) standard stereotactic space (Friston et al., 1995). Data were re-sampled to $2 \times 2 \times 2$ mm (8mm$^3$) isotropic voxels. All volumes were smoothed with an isotropic Gaussian kernel of 8mm full-width at half-maximum.

**Statistical analysis**

After pre-processing, analyses were performed using the general linear model (GLM) and random effects models for second-level analysis (Friston et al., 1995). First, we computed a GLM for each participant, which included regressors for the six conditions (including conditions of no interest) and also one for the inter-run instructions, convolved with a canonical hemodynamic response function. Rota-

tional and translational head movements were added as nuisance variables (6 covariates). For each voxels a high-pass filter (cut-off 128$s$) was applied to remove low-frequency noise from the fMRI time series. In addition to the standard procedure of excluding low-intensity voxels (implicit masking), a binarized version of the standard grey matter mask provided by SPM8 was used as explicit mask. The following contrasts were computed: PEN > NEU, BOD > NEU, DIS > NEU. To assess hemodynamic changes at the group level, the results of these weighted contrasts (contrast images) were entered into a second-level flexible factorial model. We specified one factor ('Contrast', independence 'no'; variance 'equal') with three levels representing the three contrast images. As covariates we entered individual stIAT scores and subjective ratings for PEN stimuli. Because of multicollinearity between regressors, VAS-disgust ratings were orthogonalized with respect to stIAT scores. We specified one main effect (Contrast) and three interaction effects (stIAT $\times$ Contrast, VAS-disgust $\times$ Contrast, VAS-pleasure $\times$ Contrast).

Main contrasts and conjunctions between contrasts were thresholded at $p < .05$, family-wise error (FWE) corrected for multiple comparisons. Conjunction analysis was performed to investigate the overlap of PEN- and DIS-related brain activity following the more stringent 'conjunction null hypothesis' method. Correlations between contrasts and VAS and stIAT scores were initially thresholded at $p < .001$ uncorrected. In this instance, clusters were considered significant if their peak voxel reached $p < .05$, FWE corrected for multiple comparisons. For the stIAT we expected effects to occur in a rather circumscriptive set of areas, and we therefore also accepted clusters that reached $p < .05$, corrected for a reduced search space. In the case of VAS ratings we had no clear expectations on where brain activity would be sensitive to such ratings and we therefore adjusted the critical alpha for the fact that we included VAS ratings for two dimensions, rendering areas significant if they reached a FWE corrected $p < .025$. The mask that served as reduced search space for stIAT-related brain effects (8846 voxels) was designed to comprise all deep brain nuclei as well as cortical areas thought to mediate sexual interest (anterior insula, perigenual cingulate cortex, orbitofrontal cortex). A ROI representing bilateral anterior (agranular and dysgranular) insula was hand-drawn on a brain template following the anatomical description by Nanetti et al. (2009). A ROI representing bilateral perigenual ACC was also hand-drawn, following the description in Palomero-Gallagher and colleagues. Caudate, putamen, accumbens, amygdala, hypothalamus, thalamus, and pallidum ROIs were taken from the Harvard-Oxford Subcortical Atlas `http://www.cma.mgh.harvard.edu/`, while ROIs basal forebrain and brainstem ROIs were hand-drawn. Because of susceptibility artifact, the orbitofrontal cortex was not included in the mask.

## 6.3 Results

### 6.3.1 Subjective Evaluation of the Still Stimuli

Table 6.2 illustrates the subjective evaluation of each stimulus-type on the dimensions of disgust, pleasure and (post hoc) general arousal.

Table 6.2: Subjective evaluation of each stimulus-type on two dimensions.

| Emotion | DIS M (SD) | PEN M (SD) | BOD M (SD) | NEU M (SD) |
|---|---|---|---|---|
| Disgust | 79.3 (13.2)$^{a,x}$ | 27.0 (24.7)$^{b,z}$ | 1.6 (2.2)$^{c,y}$ | .60 (.7)$^{d}$ |
| Pleasure | 5.3 (6.7)$^{a,y}$ | 40.0 (24.2)$^{b,z}$ | 56.4 (11.7)$^{c,v}$ | 29.3 (25.3)$^{d}$ |
| Arousal (general)# | 36.28 (18.4) | 39.01 (22.7) | 10.03 (10.2) | 5.08 (8.7) |

The subjective evaluation of each stimulus-type (DIS, disgust; PEN, Sexual penetration; BOD, neutral bodies; NEU, neutral stimuli) on the 2 dimensions, namely, disgust, and pleasure. Different letters in superscript (a/b/c/d) indicate significant difference between stimulus categories within a dimension ($p < .012$). For instance, the 'a' on DIS and the 'b' on PEN elicitors on the first row indicates that they do differ significantly from each other on the dimension of disgust. The 2nd letter $(x, y)$ applies to relevant comparisons across columns. For instance the '$z$' of the dimension of disgust with the '$z$' on the dimension of pleasure indicates that the stimulus material - PEN did not differ significantly on these two dimensions ($p = .19$). All stimuli were rated subjectively on the dimension of general arousal post hoc due to connotations to positive arousal for the Dutch word ('opwinding') that we used in the experiment (see Method).

Participants' picture ratings were subjected to a 4 Picture (BOD, NEU, PEN, DIS) $\times$ 2 Emotion (pleasure, disgust) mixed between-within subject ANOVA. The pictures elicited a differential pattern of emotional ratings as evidenced by the significant interaction of Picture $\times$ Emotion, Wilk's $\lambda = .17,\ F(3, 19) = 54.1,\ p < .001,\ \eta^2$=.74. The general pattern of subjective ratings attests to the validity of the stimulus materials (Table 6.2). To examine in more detail whether the stimulus material was effective in eliciting the intended affect we evaluated the relevant comparisons by means of t-tests (Table 6.2).

As can be seen in Table 6.2, DIS stimuli elicited higher subjective disgust than BOD $[t(19) = 4.78,\ p < .001,\ \eta^2 = .55]$ and PEN $[t(19) = 8.77,\ p < .001,\ \eta^2 = .80]$. Similarly, DIS also elicited less subjective pleasure than BOD $[t(19) = 21.51,\ p < .001,\ \eta^2 = .96]$. In the same vein PEN not only elicited more pleasure than DIS $[t(19) = 6.50,\ p < .001,\ \eta^2 = .68]$, but also more disgust than BOD $[t(19) = 4.79,\ p < .001,\ \eta^2 = .54]$. In fact PEN did not differ significantly on the dimension of subjective elicited disgust and pleasure $[t(19) = 1.35,\ p = .19,\ \eta^2 = .08]$ indicating that participants reported an ambivalent subjective appreciation of PEN stimuli.

*Index of the relative automatic disgust-PEN associations.* The results of the stIAT associations are shown in Table 6.1 in terms of both mean RTs (as a function of block) and the $D_4$ -measure score.

To test the alleged relationships between the relative automatic index ($D_4$-measure) of sex associations and the subjective ratings of PEN stimuli we computed bivariate Pearson correlations between stIAT on the one hand, and the subjective disgust and pleasure elicited by PEN stimuli on the other. In line with the starting point that the implicit and explicit measures reflect largely independent constructs there were only small correlations between the $D_4$ measure and the subjective ratings; the correlations between stIAT on the one hand with subjective disgust and pleasure on the other were $r = -.31$ $(p = .18)$ and $r = .16$ $(p = .49)$, respectively.

### 6.3.2 fMRI results

*Contrasts of interest:* We first computed the contrast BOD > NEU to have a global picture of the main brain responses to pleasant bodily interactions. This contrast yielded comparatively few areas that surpassed the significance threshold of $p < .05$, FWE corrected for multiple comparisons. The largest cluster was centered on the right occipitotemporal cortex and stretched to the contralateral side to include primary visual areas and the left occipitotemporal cortex. This part of the occipitotemporal cortex houses the extrastriate body area. A much smaller cluster was found more anterior on the ventral aspect of the inferior temporal gyrus, possibly representing the fusiform body area. PEN > NEU not only activated the above occipitotemporal areas to a much stronger extent, the activated cluster was also much larger, radiating all the way up to dorsal parts of the parietal lobe. In addition, there was marked activation of many subcortical areas, with hotspots on the posterior thalamus and midbrain, and on bilateral ventral pallidum. In the latter, activity stretched ventrally to the amygdala, and medially to the hypothalamus. Additional significant activation was seen in bilateral cerebellum, left anterior insula, paralimbic middle cingulate cortex, and bilateral inferior frontal gyrus. The reverse contrasts (i.e. deactivations) did not yield significant clusters. To investigate the overlap between PEN and DIS-related brain response patterns, we performed a formal statistical analysis of the shared (conjugated) activity in PEN > NEU and DIS > NEU activation maps. This analysis revealed that the overlap between these maps was striking, even using very stringent statistical criteria. Shared activity was seen in bilateral occipitotemporal cortices, in the right superior parietal lobule, the right amygdala, the posterior thalamus and the midbrain. However, in some of these areas (right superior parietal lobule, right occipitotemporal cortex) PEN induced stronger activity than DIS. The reverse was the case in the right postcentral gyrus.

Table 6.3: Main contrasts.

| **BOD > NEU** | $k$ | $x$ | $y$ | $z$ | $Z$ |
|---|---|---|---|---|---|
| *Right* | | | | | |
| mid temp gyr / occ temp c | 3585 | 48 | −74 | 0 | 7.80 |
| (incl contralat struct)inferior temporal gyrus | 64 | 44 | −42 | −10 | 5.68 |
| **PEN > NEU** | | | | | |
| *Right* | | | | | |
| mid temp gyr/occ temp c/sup par lob (incl contralat struct) | 20288 | 48 | −72 | −2 | $\infty$ |
| inferior frontal gyrus | 358 | 44 | 8 | 28 | 6.51 |
| midbrain / thalamus (posterior) | 629 | 10 | −26 | −14 | 5.83 |
| cerebellum | 12 | 24 | −42 | −42 | 5.19 |
| middle cingulate cortex | 21 | 4 | 8 | 28 | 5.05 |
| ventral pallidum / amygdala | 76 | 16 | −2 | −10 | 5.02 |
| precentral gyr | 20 | 36 | −2 | 50 | 4.96 |
| *Left* | | | | | |
| cerebellum | 26 | −18 | −44 | −42 | 5.59 |
| middle frontal gyrus | 68 | −26 | −2 | 50 | 5.46 |
| inferior frontal gyrus | 40 | −48 | 8 | 30 | 5.43 |
| anterior insula | 7 | −24 | 8 | −16 | 4.84 |
| hypothalamus / ventral pallidum | 5 | −8 | −4 | −10 | 4.68 |
| **PEN > DIS** | | | | | |
| *Right* | | | | | |
| Occ temp c | 764 | 50 | 60 | 6 | 6.79 |
| Inf par lob/sup par lob | 755 | 50 | 26 | 44 | 5.79 |
| *Left* | | | | | |
| Mid temp gyr/occ temp c | 334 | 48 | 72 | 4 | 6.07 |
| Sup par lob | 186 | 32 | 50 | 56 | 5.55 |
| Inf par lob | 70 | 52 | 28 | 40 | 5.37 |
| **DIS > PEN** | | | | | |
| Postcentral gyrus | 31 | 42 | 16 | 54 | 5.08 |

The results from the following contrasts are listed: BOD > NEU, i.e. between images depicting neutral bodily male-female interaction and a neutral condition of inanimate objects; PEN > NEU, i.e. between hardcore pornography focused on penile-vaginal penetration and the same inanimate objects; comparisons between PEN > NEU and DIS > NEU activation maps including a conjunction analysis showing the shared activity between them. Stimuli in the DIS condition depicted highly aversive core disgust stimuli. All clusters listed reached $p < .05$, FWE corrected. The reverse contrasts (i.e. deactivations) did not yield significant clusters. Clusters are listed with coordinates $(x, y, z)$ of the peak voxel in MNI (Montreal Neurological Institute) standard space, and size ($k$ voxels). The peak $Z$ scores are provided. Inf, infinite; gyr, gyrus; mid, middle; occ, occipital; inf, inferior; par, parietal; lob, lobule; sup, superior; temp, temporal, post, posterior; cing, cingulate; c, cortex. contralat struct, contralateral structures.

| **PEN > NEU∧DIS > NEU** | | | | | |
|---|---|---|---|---|---|
| *Right* | | | | | |
| Mid temp gyr/occ temp c | 4688 | 46 | 74 | 2 | 7.76 |
| Sup par lob | 234 | 28 | 52 | 48 | 5.52 |
| Thalamus (post) | 48 | 22 | 28 | 2 | 5.19 |
| Amygdala | 5 | 20 | 4 | 12 | 4.83 |
| *Left* | | | | | |
| Mid temp gyr/occ temp c | 4026 | 40 | 74 | 10 | 7.48 |
| Midbrain/thalamus (post) | 43 | 8 | 28 | 2 | 5.05 |

Continuation of Table 6.3

*Modulation of PEN-induced brain activity by subjective reports of disgust and pleasure.* We went on to explore the correlation of PEN-induced brain activity (PEN > NEU) with the subjective scores of elicited disgust and pleasure as measured on the VAS. PEN-induced brain activity was modulated much more prominently by disgust than by pleasure ratings. Significant correlations with VAS-disgust were found predominantly in the posterior part of the brain. A large cluster, centered on the right ventrolateral occipitotemporal cortex stretched considerably to include the posterior thalamus, the midbrain and even the posterior cingulate cortex and left hippocampus and parahippocampal gyrus. PEN-induced activity in the right hippocampus and amygdala was also significantly associated with VAS-disgust, but these areas represented a separate cluster. The right middle frontal gyrus, the left temporal pole and left ventrolateral occipitotemporal cortex, and the calcarine gyrus and bilateral superior parietal lobule showed the same significant relationship with individual disgust ratings. Note that the significance threshold for these analyses was $p < .025$.

Pleasure ratings significantly modulated activity in the left ventrolateral occipitotemporal cortex and in the calcarine gyrus extending into the occipitoparietal junction, possibly representing the inferior part of the superior parietal lobule. Significant negative correlations with PEN-induced activity were observed neither for VAS-disgust nor for VAS-pleasure.

*Modulation of PEN-induced brain activity by implicit PEN-associations.* The final step was to connect individual stIAT scores with brain activity. It appeared that individual implicit PEN associations selectively modulated PEN-related activity. DIS- or BOD-related brain activity showed no relationship with stIAT scores. The nature of the interaction between individual stIAT and PEN-related brain activity was such that stronger negative PEN associations correlated with enhanced BOLD activity. Such modulation was significant in a limited number of areas: the right superior parietal lobule, the midbrain, the rostral basal forebrain, and the right amygdala. The midbrain cluster was on the right side, centered ventrolaterally to the periaque-

ductal gray matter. The basal forebrain cluster was centered on the left bed nucleus of stria terminalis (BNST), but radiated medially to include the lateral septal nuclei (LS) and the same structures on the right side.

Additionally, this cluster included the caudal-most part of the nucleus accumbens on both sides (Mai et al., 2005). Note that the cluster clearly stays dorsal and rostral to the anterior commissure (Figure 6.2, excluding the possibility that the hypothalamus was involved. Also note that for midbrain, basal forebrain, and amygdala significance was obtained after correction for a reduced search space (see Methods), which was justified because of our a priori expectation that deep brain areas would be most sensitive to modulation by the stIAT. Table 6.5 lists these effects, while in Figure 6.2 both their anatomical location as well as the relationship between BOLD activity and individual stIAT is depicted. There were no areas in the individual PEN > NEU maps where activity could be explained by increasing positivity of stIAT-PEN associations.

Table 6.4: Modulation of PEN-induced brain activity by subjective elicited affect

| VAS Disgust × (PEN>NEU) | $k$ | $x$ | $y$ | $z$ | $Z$ | $Pcorr^*$ |
|---|---|---|---|---|---|---|
| *Right* | | | | | | |
| calcarine gyr / mid occ gyr | 242 | 26 | −76 | 10 | 5.79 | .000 |
| inf occ gyr / occ temp c / post cing c / hipp / midbrain / thalamus (post) | 11921 | 50 | −68 | −14 | 5.58 | .001 |
| hippocampus /amygdala | 435 | 22 | −16 | −24 | 5.29 | .003 |
| temporal pole | 194 | 58 | 4 | −12 | 4.96 | .012 |
| *Left* | | | | | | |
| inf par lob / sup par lob | 1291 | −36 | −70 | 48 | 5.64 | .000 |
| middle frontal gyrus | 798 | −28 | 32 | 46 | 5.13 | .006 |
| inf temp gyr / occ temp gyr | 393 | −46 | −50 | −14 | 5.02 | .009 |
| VAS Pleasure × (PEN>NEU) | | | | | | |
| *Right* | | | | | | |
| calcarine gyrus | 62 | 28 | −74 | 8 | 5.01 | .010 |
| inf par lob / sup par lob | 969 | 30 | −52 | 34 | 4.84 | .021 |
| *Left* | | | | | | |
| inf temp gyr / occ temp c | 192 | −46 | −50 | −14 | 5.18 | .005 |

Individual PEN>NEU activation maps were correlated against subjective elicited disgust and subjective elicited pleasure as reported on the Visual Analogue Scale (VAS). Interaction maps were thresholded at $p < .001$, uncorrected, but only clusters that reached $p < .025$, FWE corrected for multiple comparisons, are listed (because of two VAS scales tested, see Methods). Clusters are listed with coordinates $(x, y, z)$ of the peak voxel in MNI (Montreal Neurological Institute) standard space, and size ($k$ voxels). The peak $Z$ scores are given along with corrected $p$ values. gyr, gyrus; mid, middle; occ, occipital; inf, inferior; par, parietal; lob, lobule; sup, superior; temp, temporal, post, posterior; cing, cingulate; c, cortex; hipp, hippocampus.

Table 6.5: Modulation of PEN-induced brain activity by implicit PEN-associations

| stIAT × (PEN>NEU) | $k$ | $x$ | $y$ | $z$ | $Z$ | $Pcorr$ |
|---|---|---|---|---|---|---|
| *Right* | | | | | | |
| sup occ gyr / sup par lob | 172 | 28 | −76 | 42 | −5.32 | .002 |
| midbrain | 234 | 8 | −24 | −16 | −5.22 | .003∗ |
| amygdala | 72 | 28 | −6 | −20 | −3.98 | .039∗ |
| *Left* | | | | | | |
| basal forebrain | 104 | −6 | 4 | −6 | −4.40 | .019* |

Individual PEN>NEU activation maps were correlated against individual scores on the single target Implicit Association Task (stIAT, with PEN-like stimuli as targets). Interaction maps were thresholded at $p < .001$, uncorrected, but only clusters that reached $p < .05$, FWE corrected for multiple comparisons, are listed. The basal forebrain cluster included left bed nucleus of stria terminalis (BNST), lateral septal nuclei (LS), and part of the nucleus accumbens on both sides (see results for detailed anatomical description). Clusters are listed with coordinates $(x, y, z)$ of the peak voxel in MNI (Montreal Neurological Institute) standard space, and size ($k$ voxels). Peak $Z$ scores are given along with corrected p values. gyr, gyrus; occ, occipital; sup, superior; par, parietal; lob, lobule. $*p < .05$ FWE, for reduced search space (see Methods for further detail).

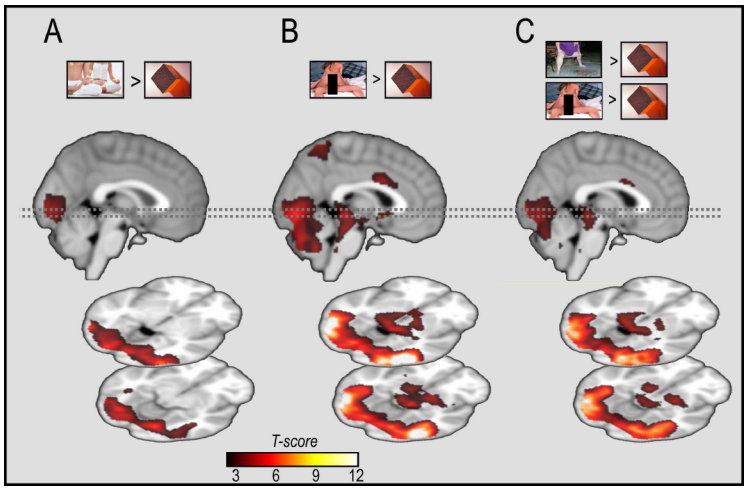



Figure 6.1: A baseline emotional category of neutral objects (NEU) was subtracted from a condition consisting of neutral male-female bodily interactions (BOD, panel A) and from a condition consisting of hardcore pornographic images focusing on penile-vaginal penetration (PEN, panel B). PEN is clearly superior with respect to the BOLD activity it induces relative to NEU. However, most of these areas showed the same response to highly aversive core disgust stimuli (DIS), as shown by a conjunction analysis on PEN>NEU and DIS>NEU activation maps (panel C). Activation maps were thresholded at p<.001 uncorrected for display purposes.

## 6.4 Discussion

To our knowledge this study is the first to examine the modulatory position of implicit PEN-disgust relative to PEN-'hot' associations in central VSS processing. The present findings first revealed that many parts of the brain responded to pornography (PEN) in the same way they responded to highly disgusting (DIS) stimuli. This was supported by the finding that the elicited disgust to PEN explained much more variance in PEN-induced brain activity than the elicited pleasure towards the same stimuli. Second, women with relatively negative (i.e. disgust-related) implicit PEN associations had the strongest PEN-related brain responses. However, this modulation applied to a limited set of mainly primordial brain areas (Figure 6.2). Furthermore, this relationship was specific for PEN: brain responses elicited by BOD or DIS were not modulated by PEN associations as measured on the stIAT, which supports the validity of this finding that it is not reflecting a general difference in stimulus processing. These findings delve into the complexity of processing VSS, and unveil the important modulatory role of disgust to these specific penetration stimuli, at least in women.

In this study we meticulously controlled for phase of menstrual cycle, relationship status, and type of anti-conception use. Moreover, the PEN stimuli we used were of a much more explicit nature than the erotica commonly used in (sexual) neuroimaging studies. Furthermore, we included an arousing but aversive control condition (DIS) to test the specificity of the findings. Indeed, a statistical test for shared brain activity in PEN- and DIS-related activation maps demonstrated substantial overlap between the two stimulus categories, which is in line with recent insights on central visual emotion processing that emotionally very distinct sexual and disgust stimuli bring out very similar brain activity (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). This overlap particularly pertains to deep brain structures like the amygdala, ventral pallidum, thalamus, and midbrain, as well as neocortical areas like the vOT and SPL. At least some of this overlap (e.g. amygdala, thalamus, vOT, SPL) may be explained by the considerably heightened general arousal and attention that invariably accompany disgusting and erotic images (Walter et al., 2008).

Valence probably played a less significant role, if any: BOD was rated highest on 'pleasure', but PEN nevertheless induced much stronger activity in many brain areas (Figure 6.1). It could very well be that the BOD stimuli were relatively more pleasant due to their mildness, contrasting with the harsh edge of the PEN stimuli. PEN, on the other hand, was remarkable for eliciting moderate subjective disgust as well as pleasure, rendering it the most ambivalent among the present stimuli (Peterson and Janssen, 2007).

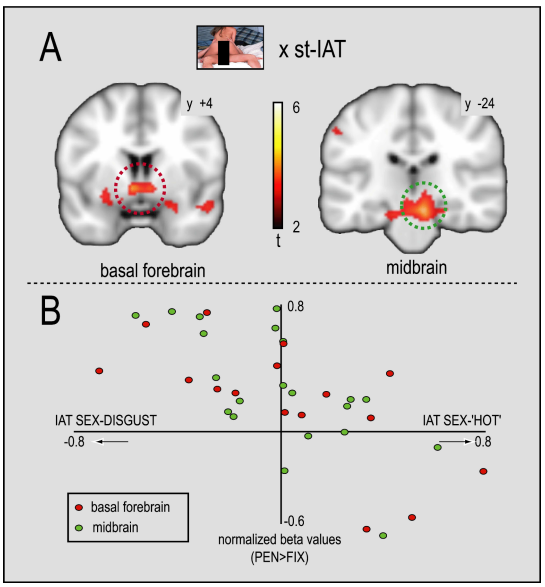



Figure 6.2: Implicit associations with explicit pornography modulate subcortical responses to PEN. The top half of the figure highlights two of the areas where activity is modulated by individual stIAT scores: the midbrain (right, green) and basal forebrain including BNST, LS, and nucleus accumbens (left, red). The right amygdala involvement is also visible in the basal forebrain section. In the bottom part of the figure activity in these areas is plotted against individual stIAT scores. Mean activity from these areas was extracted with MarsBar, which used the PEN > FIX (fixation cross) contrast to ensure that effects were driven by the PEN condition. Note that activity in these areas clearly tracks with the relative negativity of stIAT scores (i.e. relative PEN-disgust associations). $p < .005$, uncorrected, for display purposes (top half of figure)

When we connected individual stIAT scores to brain activity, these scores selectively modulated the PEN activation maps, even when DIS activation maps were very similar (Figure 6.2). In line with a previous fMRI study that included IAT scores (Phelps et al., 2000), and with other fMRI studies on subliminal brain responses to VSS (Childress et al., 2008; Oei et al., 2012), this coupling predominantly involved deep brain areas. Specifically, stIAT-PEN scores modulated activity in the rostral basal forebrain the midbrain and the right amygdala (Figure 6.2). The only other area exhibiting this correlation was the right superior parietal lobule. This modulation in these areas turned out to be of a negative nature, namely, stronger PEN-disgust relative to PEN-'hot', implicit associations gave stronger activity (Figure 6.2).

Women's subjective reports of disgust towards PEN also correlated with mid-

brain and amygdala, whereas such a correlation was absent for pleasure ratings. Superior parietal lobule activity was connected to both VAS-disgust and VAS-pleasure, which corresponds to the idea that activity of this area reflects heightened attention to - or emotional capture by - bodies (Kret et al., 2011). Interestingly, SPL consistently activates in response to VSS (Georgiadis and Kringelbach, 2012), except when subjects begin to show signs of sexual arousal, e.g. penile erection (Cera et al., 2012; Georgiadis and Kringelbach, 2012). This could be taken to support that it is the initial heightened attention related to the processing of a highly emotional stimulus, and not the valence per se, that is reflected in activation of this area. The finding that VAS-disgust explained more variance in PEN-induced brain activity than did the PEN-disgust stIAT is supported by similar observations for supraliminal versus subliminal processing of VSS (Gillath and Canterberry, 2012). This could be related to the stIAT being a very specific (and relative) measurement of two constructs (i.e., PEN-disgust vs. PEN-hot) whereas subjective appreciation includes a more comprehensive validation approach.

Intriguingly, some of the areas that showed a relationship with stIAT modulation (PEN-disgust vs. PEN-hot), such as the basal forebrain/nucleus accumbens, amygdala, and the midbrain (Table 6.5; Figure 6.2), have in other studies tracked the positive hedonic value of VSS (Walter et al., 2008; Sescousse et al., 2010). This apparent inconsistency may be explained by the different types of VSS used across studies. The VSS presented in the earlier studies employed relatively soft stimuli such as single nudes (Childress et al., 2008; Sescousse et al., 2010), whereas the stimuli used in the present study are hardcore pornographic stimuli.

Alternatively, some subcortical areas (amygdala, nucleus accumbens) are particularly well situated to mediate interactions between aversive and appetitive processing (Leknes and Tracey, 2008). The amygdala, for instance, houses different neuron populations that encode the hedonic value of conditioned visual reward and punishment cues at least in non-human primates (Paton et al., 2006). Such findings explain why an area may be found active under very different emotional circumstances. At any rate, within the confinements of our study there was substantial overlap between the subjective appreciation and the more implicit associations towards PEN in their modulation of PEN-induced brain activity. The current findings thus suggest that even when a similar network of areas may be responsive to a wide range of VSS, such involvement does not necessarily reflect a positive affect.

The stIAT tapped in the more imprinted value attached to PEN. Such associations in memory tend to be more stable compared to the more deliberate attitudes, and their central signature accordingly was inclined towards the subcortical level in the present study. The question is how we can understand that these areas primarily reflected the negative implicit association with PEN stimuli. We have already

seen that the amygdala may be capable of both appetitive and aversive processing (Leknes and Tracey, 2008), and that this relates to associative learning (Paton et al., 2006). The amygdala has been connected to implicit associations with race (Phelps et al., 2000), which is interesting because both race and sexuality have very strong moral connotations and associations with them, and thus are likely to be influenced by cultural forces and social learning.

Unlike amygdala and midbrain, the basal forebrain did not show significant activation in the main PEN-contrast, or a significant association with subjective ratings. Thus we may conclude that its activity is particularly relevant to the workings of implicit associations (as measured by the stIAT). The cluster was centred on the left bed nucleus of stria terminalis (BNST), but included the lateral septal nuclei (LS) and (part of) the nucleus accumbens. The BNST/LS, has strong functional and anatomical ties with the midbrain and especially amygdala (Alheid et al., 1998). A recent review argued that BNST/LS is instrumental in producing a behaviourally appropriate response to a social stimulus, sexual incentives transmitted by a conspecific being a typical example (O'Connell and Hofmann, 2011). In male rats their BNST/LS has indeed been connected to processing airborne sex odours (Power and Dalgleish, 1997). Likewise in men, clusters reported as 'ventral striatum' or 'nucleus accumbens', but located so medially that the BNST/LS likely contributed to the signal change, seem particularly responsive to VSS (Walter et al., 2008; Sescousse et al., 2010; Klucken et al., 2009). Thus it seems reasonable to assume that human BNST/LS function has relevance for processing sexual signals. A different literature proposes that the BNST is most relevant in the elaboration of sustained anxiety states, whereas midbrain and amygdala activity is implicated in transient fear and conditioned fear responses (Somerville et al., 2012; Duvarci et al., 2009; Walker et al., 2003). Interestingly, BNST function is regarded as a reliable predictor of inter-individual differences in anxiety (Somerville et al., 2012; Duvarci et al., 2009), which fits with the present finding that PEN-induced BNST/LS activity was sensitive to inter-individual variability in the way women connected implicitly to PEN. Translating this information to the present results, one might propose that BNST activity primarily reflected the tension between the social context and the sustained negative association with PEN. Midbrain and amygdala activity could then underlie the associated transient negative feeling of bewilderment.

Obviously, VSS carry high relevance for our social behaviour: If preferred, such stimuli may make us want to approach. On the other hand, social learning mechanisms can alter the value attached to these stimuli in various directions, depending on elements like context and mnemonic associations. Whether the stIAT-related brain effects would be predictive of behavioural inhibition in real-life sexual situations remains to be investigated.

Several comments are in order here. First, we did not directly assess sexual desire or arousal, so it cannot be excluded that PEN-induced brain activation would also be related to subjective sexual desire, arousal or lust. Genital responses were not measured, and it can thus not be ruled out that these women did in fact show physiological sexual arousal in spite of their inclination towards negative appreciation of PEN (Rellini et al., 2005; Laan and Both, 2011; Both et al., 2011). Additionally, based on the used design (which lacks an obvious positive valence stimulus category) it cannot be ruled out that the same modulatory effect of stIAT on brain activity would not also be observed in relation to a positive appreciation towards emotional stimuli. Second, the PEN stimuli were of a very explicit type, and both stIAT effects and stIAT-related modulations of brain activity may prove to be different with milder erotic stimuli. Third, the design of this study cannot resolve whether effects were due to implicit brain processes (like e.g. in a paradigm where pictures are presented subliminally), even when significant correlations between individual stIAT scores and BOLD activity were restricted almost exclusively to a subset of sub-cortical areas. This is relevant because similar activations have been found rather consistently in fMRI paradigms with on-magnet subliminal presentations of VSS (Gillath and Canterberry, 2012; Oei et al., 2012; Childress et al., 2008). Also, relevant is the point that although the IAT (interference) effects are assumed to be caused by participants' implicit attitudes towards the target (e.g., PEN) stimuli (Greenwald et al., 2003), people do need to explicitly process the PEN stimuli in order to make the proper choices, even if participants are asked to do this categorization as fast as possible. In view of that, the link between stIAT and BOLD response may then reveal the shared component of the automatically activated affective (PEN-disgust) associations with explicitly processed sexual stimuli. As a final point, the spatial resolution of the present fMRI study makes it difficult to pinpoint activity to anatomical areas with relatively minor size, such as the BNST or LS.

## 6.5 Conclusion

The dependence of reproduction on sexual behaviour often leads people into assuming that sexual cues have a fixed value and that associations with such stimuli are positive. However, human sexual behaviour is flexible and complex. Over the course of our life there may be many experiences, circumstances, and cultural influences that shape the way we connect to particular sexual stimuli and consequently the attitudes we hold towards them. Our findings indicate brain activity that reflects an apparent negative appreciation towards pornography. This could be explained by attitudes towards porn imposed by social sexual morale, the lack of positive ex-

posure and associations of porn or the mere difficulty to actually integrate the new learning with previous experiences towards a more positive appraisal. Psychological mechanisms like this may more frequently affect women (Widmer et al., 2009).

In any case, our findings raise doubt whether all brain activity induced by such stimuli can safely be assumed to be a signature of a positive sexual incentive value, which is nevertheless the dominant sentiment in VSS neuroimaging studies. It seems more plausible that processes involved in assessing the meaning or significance of a possible sexual incentive in relation to associations in memory, experiences, context, and other elements, are major leads of brain activity. Future studies should try to dissect different routes for ambivalent, positive and negative sexual associations and to investigate how they influence subsequent behaviour.

# Appendix 6.A. Supplementary material, st-IAT

*Single Target Implicit Association Test (stIAT).* The stIAT is a computerized reaction time (RT) task that measures to what extent a single-target category is associated with two attribute categories. In this study, the stIAT was used to measure the relative disgust vs. hot automatic associations with PEN (stimuli). Pictures with sexual penetration content formed the (single) target in the task, and the attributes consisted of negative/disgust vs. positive/'hot' words.

The stIAT consisted of two test phases preceded by a practice phase. Participants were instructed to categorize words of the three categories that appeared in the middle of a computer screen by means of two response buttons. In one test phase 'sex' and 'disgust' were mapped on a single response key, and 'hot' on the other. The idea is that the task becomes easier when two pairings that are strongly associated, share the same response key. Consequently, the difference in RT between both test phases is assumed to reflect whether sex is associated more strongly with either attribute category (Table 6.6 - supplementary material).

During the stIAT, the labels of the categories assigned to the left and right keys were presented in the upper left and right corners of the screen, respectively. Following a correct response, the stimulus was immediately replaced by a fixation dot and replaced by the next stimulus after 500$ms$. Following an incorrect response, the word 'false' appeared shortly above the stimulus. The stimulus remained on the screen until the correct answer was given.

In line with previous research, stIAT effects were computed on the basis of the attribute trials only. Pictures (here, the targets) are processed differently from (attribute) words. In addition, the targets in this study did not require a decision based on content. Participants were extremely fast on picture trials, and interference due to automatic associations seems most likely during attribute trials. RTs were analysed using the now widely used $D_4$-measure scoring algorithm (Greenwald et al., 2003). Following these guidelines, all RTs above 10,000$ms$ were discarded. Error trials were replaced with the mean RT of the correct responses in the block in which the error occurred, plus a penalty of 600$ms$. The stIAT effects were calculated by subtracting the mean RT of Block 2(4) from Block 4(2) (test). The mean of these two effects was divided by their pooled standard deviations. In this paper, we report the $D_4$-measure (Table 6.1). Here, negative stIAT effects (i.e., negative $D_4$-measure) indicate relatively fast responses when sex shared the response key with disgust. Hence, in this stIAT, negative $D_4$-measure means more sex-disgust associations.

Table 6.6: st-IAT

| Block | Left Hand | Right Hand |
|---|---|---|
| 1(20) | Disgust (5) / Sex (5) | Hot (10) |
| 2(59) | Disgust (15) / Sex (15) | Hot (29) |
| 3(20) | Disgust (10) | Hot (5) / Sex (5) |
| 4(59) | Disgust (29) | Hot (15) / Sex (15) |

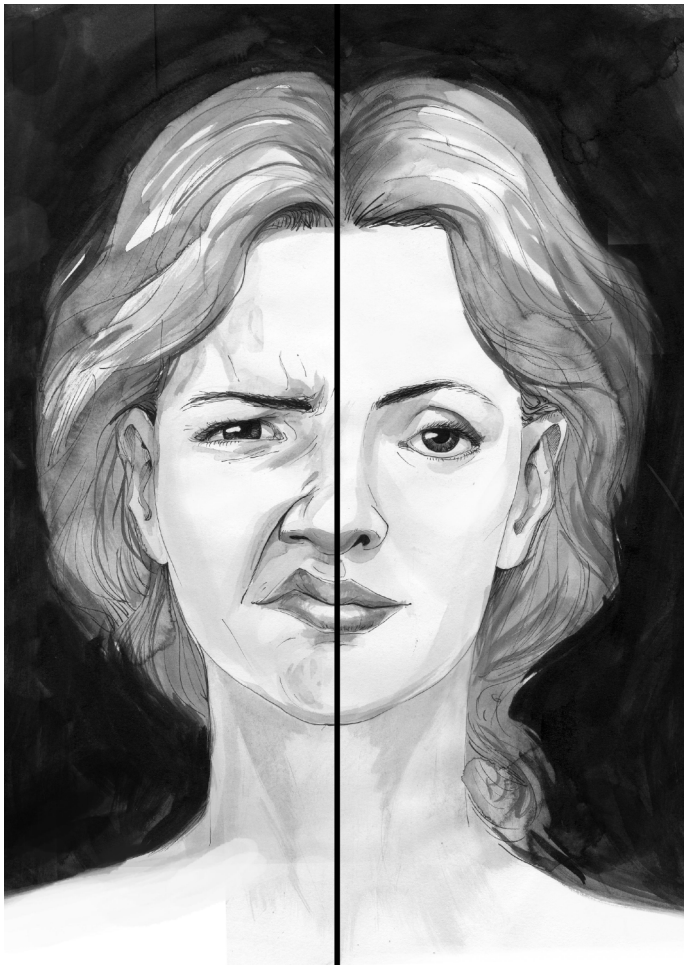
**Note:** Trials number of each stimuli category for each block is given in () parentheses. The processed picture-stimuli - in this task the targets were always the PEN stimuli.

A sample of words included:

- 'Hot' category: delicious, pretty, and pleasant; in Dutch - heerlijk, leuk, and prettig,
- Disgust category: dirty, dirty, and aversion; in Dutch - vies, smerig, and weerzin.

## Section III

# Brain processing in penetration disorders



# Chapter 7

# Brain processing of sexual penetration, core and animal-reminder disgust pictures in women with penetration disorders.

**Abstract**

*Disgust is typified by the overwhelming urge to avoid contact to prevent transmission of pathogens and thereby contamination to occur. Consistent with such a disease-avoidance conceptualization, disgust is typically focused on the intersection between the body and the environment. From this standpoint, vaginal penetration is an obvious threat for the transmission of disease and may thus be expected to elicit disgust responses. Accordingly, it has been proposed, that the involuntary muscle contraction characteristic of penetration disorders may be elicited by the (implicit) prospect of penetration by a potential contaminant. This disgust-based interpretation of penetration disorders is consistent with recent views that framed vaginismus as a specific phobia of penetration. In this study with 3 groups, women with vaginismus ($n$ = 20), women with dyspareunia ($n$ = 21) and controls ($n$ = 21), functional magnetic resonance imaging (fMRI) was implemented to test if women with penetration disorders would have stronger convergence in their penetration- and disgust-induced brain activation. Stimulus materials consisted of two types of disgust elicitors (animal-reminder, core), penile-vaginal penetration, neutral-bodies, fear and neutral-objects. The findings can be summarized as follows: there was a large overlap between disgust and penetration stimuli across the three groups. This overlap between penetration- and disgust-induced brain activation was restricted to animal-reminder rather than to core disgust, which is in line with the predominant model of disgust, namely that animal-reminder disgust is more related to bodily type of pathogen transmission such as penetration. Considering the ambiguity that women seem to have towards penetration (procreation vs. contamination) in the lab context, the default disgust response probably overruled, especially in the absence of sexual arousal/readiness. All in all, this paper is a first attempt to tap in the underpinnings of the neural correlates of the negative emotional responses toward sex (vaginal-penetration) stimuli in women with and without penetration disorder.*

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## 7.1 Introduction

After being labelled as the 'forgotten emotion of psychiatry' just over a decade ago (Phillips et al., 1998), disgust has increasingly been given the spot light. Thus far however, the majority of disgust research focused on its role in various types of anxiety disorders, such as specific phobia (Bianchi and Carter, 2012), obsessive compulsive disorder, and post-traumatic stress disorder (Engelhard et al., 2011). More recently, it has been suggested, that disgust might also be a factor in certain forms of sexual dysfunction (de Jong et al., 2013; Tybur, 2009). Accordingly, disgust may also help explain the mechanisms underlying the inability to have penile-vaginal penetration that is characteristic for vaginismus, perhaps the most perplexing and poorly understood of the sexual dysfunctions.

In light of the functional properties of disgust and its phenomenology, it seems highly conceivable that indeed disgust might be involved in vaginismus. It has been proposed that disgust evolved as a first line of defence to protect humans from contamination by infectious agents (Curtis et al., 2011; Oaten et al., 2009). The overwhelming urge to withdraw from the disgusting cue facilitates the avoidance of physical contact with and/or ingestion of pathogens. Consistent with such a disease-avoidance conceptualization, disgust is typically focused on the intersection between the body and the environment and concentrates on the skin and body apertures (Fessler and Haley, 2006; Rozin et al., 1995). Because vaginal intercourse represents an obvious threat for the transmission of disease, the above disease-avoidance conceptualisation would predict vaginal intercourse/penetration to be a central elicitor of disgust responses. Accordingly, it has been proposed, that the involuntary contraction (i.e., flinching) of the pelvic floor muscles that typifies vaginismus may be elicited by the (implicit) prospect of penetration by a potential contaminant (de Jong et al., 2009). Germane to this, there is evidence that contraction of the pelvic floor muscles is part of a general defence mechanism that can be elicited in the context of physical threat (van der Velde et al., 2001). It seems reasonable to assume that similar defensive contractions can also be elicited by the prospect of physical contact with disgusting stimuli (Yartz and Hawk, 2002). Such disgust-based interpretation of the vaginistic response would also be consistent with recent views that framed vaginismus as a specific phobia of (penile-vaginal) penetration (ter Kuile et al., 2009; Binik, 2010b). The vaginistic response could thus be interpreted as essentially reflecting a fear of physical contact with disgusting stimuli (de Jong and Muris, 2002), precluding sexual penetration.

Supporting this view, that disgust might indeed be somehow involved in vaginismus, women with vaginismus display relatively enhanced trait disgust propensity (i.e., tendency to respond with disgust) (de Jong et al., 2009) and heightened

self-reported sexual disgust compared to women without sexual problems (van Overveld et al., 2013). As more direct evidence for the alleged role of disgust in vaginismus, recent research demonstrated that specifically in women with vaginismus, pictures and movie film clips depicting sexual penetration elicited physiological disgust responses (as indexed by electrical activity of the facial levator labii superioris muscle) (Borg et al., 2010). As an important next step to test the alleged role of disgust in vaginismus, the present study was designed to examine whether visual stimuli most relevant to this dysfunction (i.e. penile-vaginal penetration) and universal disgust stimuli, would lead to aberrant brain activity patterns in women with vaginismus.

Given the proposed role of disgust in vaginismus, one might expect women with vaginismus to show relatively strong convergence in their responses to sexual penetration and disgusting stimuli. Interestingly, convergence in the central processing of these stimuli is also present in asymptomatic women (with no sexual complaints). We recently showed that negative implicit associations related to, or negative subjective appraisal of, sexual penetration stimuli could account for much of this overlap (Borg, de Jong and Georgiadis, 2013). Brain imaging studies employing less explicit, non-penetrative erotica have also shown overlap between (visual) sexual and disgust processing (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011), suggesting that general arousal and/or attention phenomena may be an important connecting factor (Walter et al., 2008). The overlap is mostly seen in lateral occipitotemporal cortex, superior parietal lobule, ventral pallidum, amygdala, and thalamus. As far as differences between sexual and disgust processing have been identified, they were reported in the cingulate cortex, amygdala, ventral striatum, brainstem, and ventral pallidum (Stark et al., 2005; Karama et al., 2011). The fact that the same brain area may express both overlap and specificity may be explained by the fact that pleasant and aversive stimuli may be processed by different sub-regions of the same brain area (Prevost et al., 2011).

Another potentially relevant factor is that various classes of disgust elicitors have been differentiated (Olatunji et al., 2007). Most relevant in the present context is the distinction between core and animal reminder (A-R) disgust elicitors (Rozin et al., 1999). Decaying food and faeces are prototypical examples of core disgust stimuli; injury and mutilation are prototypical A-R disgust stimuli. Most important for the current context it has been demonstrated that Core and A-R disgust elicitors are associated with distinct patterns of behavioural avoidance, different psychopathologies (de Jong and Merckelbach, 1998; van Overveld et al., 2009; Olatunji, 2004; Olatunji et al., 2007), and with differences in brain processing (Borg, de Jong, Renken and Georgiadis, 2013; Sarlo et al., 2005; Schienle et al., 2006; Wright et al., 2004). Specifically, we previously showed that activity in the right ventrolateral oc-

cipitotemporal cortex was inclined towards A-R, and that this area expressed functional connectivity that was selectively modulated by individual disgust trait. Responses in the left anterior insula also expressed individual differences in disgust trait, but this was regardless of the disgust class (Borg, de Jong, Renken and Georgiadis, 2013). Thus, it would seem highly relevant to separate A-R and core disgust, and to study their respective effect in women with vaginismus.

Therefore, this study was designed to test the hypothesis that disgust- and penetration-related brain networks overlap more in women with vaginismus than in women with no vaginistic complaints. We also asked whether this similarity is restricted to a specific class of disgust elicitors (i.e., core versus A-R disgust elicitors). To examine if the effects are specific for women with vaginismus or would reflect a more general characteristic of women with sexual problems, we not only included a symptom-free control group, but also a clinical control group consisting of women with dyspareunia. In the current version of the DSM-5 vaginismus and dyspareunia are both categorized as genito-pelvic pain/penetration disorders (GPPPD) . Yet, as a critical difference, intercourse may still be possible in dyspareunia (though painful), whereas in vaginismus sexual penetration is by definition impossible (Basson et al., 2004). A set of threatening stimuli was included to establish that the effect was due to disgust and not to negative affect per se.

## 7.2 Materials and methods

*Participants.* Sixty-nine women participated in this study against modest reimbursement (i.e., 40 Euros), seven volunteers were excluded from evaluation for a number of reasons. Basis for exclusion mainly included, excessive head motion, catastrophic feelings during scanning and poor compliance. The local Medical Ethical Committee approved the experiment, and all procedures were conducted in accordance with its standard during the entire project (2009-2013). All participants were asked to sign a written informed consent before commencing with the study.

Our sample consisted of three groups of women, i) women diagnosed with primary (lifelong) vaginismus (PV) ($n = 20$, mean age = 25.3 years, SD = 4.4), ii) women without sexual complaints ($n = 21$ mean age = 23.0, SD = 1.9) and iii) women diagnosed with dyspareunia ($n = 21$, mean age = 23.1, SD = 3.9). Most women with PV and dyspareunia were gynaecological outpatients of the University Medical Centre Groningen not yet receiving treatment. They were informed about our study, and when interested to participate, they could contact the research team to be screened over the phone for eligibility. A minority of the women in the PV and dyspareunia groups ($n = 5$) had not yet attended the gynaecological clinic but responded to

the general advertisements we used for recruitment. They self-reported as suffering from vaginal pain. All participants in the clinical groups were examined by an experienced gynaecologist and sexologist to ensure the diagnostic criteria were met before they were screened over the phone for the present study.

The general recruitment procedure involved placing leaflets in public places (e.g., libraries and supermarkets) and advertisements in local media (e.g., in women's magazines, websites, and newspapers). Women with a history of neurological or psychiatric problems, severe head trauma, drug abuse, and/or prescribed psychotropic medications were excluded. Women could only participate if they were involved in a heterosexual relationship. Those who self-reported as not suffering from vaginstic or dyspareunic complaints were not examined by the gynaecologist and sexologist. These 'healthy controls' were, however, screened over the phone and only those who had experienced sexual intercourse, and were free of sexual complaints could participate. Groups were recruited (and scanned) in an interleaved fashion.

The participants were scanned in the first half of their menstrual cycle and never during menstruation. Apart from three participants who were predominantly left handed, all participants were exclusively right handed according to the Edinburgh Handedness Inventory (Oldfield, 1971). There was no significant variation in terms of age and educational level between the three groups ($p > .08$). All women were Caucasian and fluent in Dutch language. Participants reported moderate alcohol and nicotine consumption at most.

*Diagnostic boundaries.* For our sample, the diagnosis PV was based on the criteria formulated by the international consensus committee (Basson et al., 2004), namely, 'persistent or recurrent difficulties to allow vaginal entry, where structural or physical abnormalities were ruled out during the physical examination'. The clinical interview included questions about vaginal entry, e.g. the extent to which a woman tried and succeeded to insert a finger, penis or any other object (e.g., tampon) in her vagina. Following a thorough history, the diagnostic procedure included a physical examination. To have a sense of control over the examination, the woman was informed that she has full autonomy to end the examination at any time. The gynaecologist started by guiding the woman through an anatomical description of her genital area, and once assisted to relax, the woman was asked to press against the gynaecologist finger, placed on the hymen. At this stage, in women with PV the exam was usually terminated due to over-activity of the pelvic floor and/or involuntary guarding behaviour. Inclusion in the PV group was only possible when in the context of being assisted to relax, attempts to insert a finger into the vagina elicited an involuntary guarding reaction and a report of state fear at the attempt (or

even the thought) of vaginal penetration. For the inclusion this guarding-avoidance behaviour had to be present also outside the clinic on attempts of penetration, together with the history of no previous vaginal penetration. To have a highly homogenous cohort, no women included in the PV group had a diagnosis or comorbidity of provoked vestibulodynia (PVD). By contrast, inclusion criteria for the (acquired/lifelong) dyspareunia group were persistent or recurrent pain in at least 50% of attempted or complete vaginal penetrations, with duration of six months or more. We included both deep (pain felt deep inside the pelvis during penetration) and superficial (pain felt at the introitus) dyspareunia. In this latter group, PVD characterized by *'sever, burning/sharp pain that occurs in response to pressure localized to the vulvar vestibule'* (Goldstein and Pukall, 2009), was a common underlying problem.

### 7.2.1 fMRI paradigm and procedure

**Stimuli**

The stimuli used for scanning consisted of 36 colored photographs representing six emotional categories: 'Neutral objects' (NEU) (basic and not emotionally loaded objects e.g., a mug); 'Fear' (imminent threat, e.g., a man attacking a woman with a sharp knife against her neck) (FEAR); Core disgust (CORE) (primal disgust e.g., a person vomiting); Animal-Reminder (AR) disgust (e.g., mutilation); 'Sexual Penetration' (PEN) (e.g., coital interaction, with explicit focus on penile-vaginal penetration), and 'Interacting bodies' (BOD) (minimally clothed male and female bodies interacting without sexual connotations e.g., yoga exercises). Except for NEU, all categories had a strong emphasis on bodies or bodily features. Stimuli for NEU category were chosen from the International Affective Picture System (IAPS) (Lang et al., 1999), whereas non-IAPS stimuli (all other categories) were collected by the research team in a pre-structured process. Based on characteristics agreed on a priori the research team selected 50 photographs. These characteristics included: no focus on faces; Caucasian heterosexual couples; easily recognizable features; very limited context. Selected pictures were then sent for further validation conducted with 40 females via an online survey (`www.esurveyspro.com`). This was done over and above the researchers' team selection to make sure that each stimulus from the relevant category elicited significantly more the intended emotion than the other categories. For example, the DISGUST stimuli had to elicit significantly more disgust than the other categories. The research team matched the scenes for physical features such as complexity, brightness, contrasts, and color. Apart from content-based validation, the stimuli were also validated with respect to color. No significant differences were found on the RBG color distribution ($p > .2$).

Stimuli were presented in a block design, with each block consisting of 10 pictures representing the same category. Each photograph was presented for 1.4$s$, with a 1s interval between consecutive stimuli. Six blocks (split by 16$s$ inter-block intervals), corresponding to the six stimulus categories, were run in a pseudo-randomized sequence. Six of these functional runs were acquired for each participant, separated by 30s intervals, adding up to a total duration of the fMRI experiment of 1458$s$. A psychtoolbox (`http://psyctoolbox.org`) application was developed for presentation of the experimental design.

Preceding the experiment a 'training' task was done inside the scanner. Participants were instructed to look at the pictures presented without suppressing their responses. Given the passive nature of the design participants were asked to respond (i.e., press a button) to an asterix '*' that was over-imposed on a (fixed) randomly-selected number of photographs. These responses were recorded and used here to exclude subjects, as an indication of not complying with the instructions of the study ($n = 2$), but were not used in the analysis. Post scanning, participants conducted a Visual Analogue Scale (VAS), followed by a debriefing session.

### 7.2.2 Image acquisition

Images were acquired on a Philips Intera 3T MR-scanner. A sense 8-channel head coil was used for radio frequency reception. A series of echo planar imaging (EPI) volumes were acquired to measure the blood oxygen level dependent (BOLD) effect, which entailed a T2*-weighted gradient echo sequence with a repetition time (TR) of 2000 $ms$, and an echo time of 30 $ms$. Flip angle was 70 degrees usin whole-brain acquisition (matrix size $64 \times 64$ voxels) and interleaved slice acquisition order, with an inter-slice gap of 0 mm and plane thickness of 3 mm. EPIs were acquired at $3 \times 3$ mm in-plane resolution. The (axial) images (volumes) were acquired parallel to the anterior-posterior commissure plane. In total 740 volumes were obtained per participant. A T1-weighted anatomical MRI (TR = 9ms, TE = 3.5$ms$, matrix size $256 \times 256$) and two diffusion tensor imaging (DTI) volumes of 55 slices each of 620$ms$ duration (with scan resolution of $96 \times 96$, flip angle 70 degrees) were acquired after the EPI runs. The DTI measurements were not included for this manuscript.

### 7.2.3 Image pre-processing

For image pre-processing and analysis we used Statistical Parametric Mapping software (SPM8; University College London, UK; `http://www.fil.ion.ucl.ac.uk`). For each participant, all EPI volumes were realigned to the first volume acquired, and a mean EPI image was created. The realignment parameters were in-

spected and if movements exceeded 2mm in any direction the participant was excluded from further analysis. The anatomical (T1) scan was co-registered to the mean EPI image, and subsequently all EPI images and the T1 image were spatially normalized to MNI (Montreal Neurological Institute) standard stereotactic space (Friston et al., 1995). Data were re-sampled to $2 \times 2 \times 2$ mm (8mm$^3$) isotropic voxels. All volumes were smoothed with an isotropic Gaussian kernel of 8mm full-width at half-maximum.

**Statistical analysis**

*Statistical analysis, 1st-level.* After pre-processing, analyses were performed using the general linear model (GLM) and random effects models for second-level analysis (Friston et al., 1995). First, we computed a GLM for each participant, which included regressors for the six conditions (including conditions of no interest) and also one for the inter-run instructions, convolved with a canonical hemodynamic response function. Rotational and translational head movements were added as nuisance variables (6 covariates). For each voxels a high-pass filter (cut-off 128s) was applied to remove low-frequency noise from the fMRI time series. The standard procedure of excluding low-intensity voxels (implicit masking) was used. The following contrasts were computed: CORE > NEU, AR > NEU, PEN > NEU, FEAR > NEU, BOD > NEU.

*Statistical analysis, 2nd-level.* To assess hemodynamic changes at the group level, these weighted contrasts (contrast images) were entered into three separate second-level flexible factorial models for the main effect of group (A), the main effect of condition (B), and for the interaction between group and condition (C). For models A and B we specified one factor ("Group" and "Condition", respectively) with three and five levels corresponding to the three experimental groups and five stimulus categories, respectively. For model C we entered these two factors, together with an additional factor, "Subject". We specified one main effect (Subject) and one interaction (Group x Condition). The explicit factor Subject accounted for inter-individual differences in global BOLD activity. The factor settings were independence "yes"; variance "unequal" for factor "Group", independence "no"; variance "equal" for "Condition", and independence "yes"; variance "equal" for "Subjects".

All main and interaction effects were tested at $p < 0.05$ FWE corrected for multiple comparisons. Our primary interest concerned the way women processed the images of penile-vaginal penetration. First, we computed the difference between PEN > NEU and BOD>NEU activation maps. This was done for all women, as well as per group. Between-group differences in the processing of PEN were as-

sessed using the same contrasts in the interaction model. Next, we computed by means of conjunction analysis the shared activity between PEN-related and disgust- and fear-related brain activity using the following contrasts: [(PEN > NEU - BOD > NEU)∧(CORE > NEU - BOD > NEU)], [(PEN > NEU - BOD > NEU)∧(AR > NEU - BOD > NEU)] and [(PEN > NEU - BOD > NEU)∧(FEAR > NEU - BOD > NEU)]. Again, this was done for all women and for the three groups separately.

## 7.3 Results

### 7.3.1 Subjective ratings

For the validation of the stimulus material and relevant group differences, we ran two manipulation tests: for manipulation test (i) we investigated whether AR and CORE disgust differ in how they were rated, when contrasted with FEAR and if there were differences between groups. A 3 Picture (A-R, FEAR, CORE) $\times$ 3 Emotion (pleasure, disgust, fear) $\times$ 3 Group (Vaginismus, Dyspareunia, Controls) mixed between-within subject ANOVA was conducted. In line with expectations pictures elicited a differential pattern of emotional ratings, as was evidenced by the significant interaction of Picture $\times$ Emotion, Wilk's $\lambda = .11,\ F(4, 56) = 106,\ p < .001,\ \eta = .84$. This pattern did not vary across groups as evidenced by the non-significant 3-way interaction of Picture $\times$ Emotion $\times$ Group, Wilk's $\lambda = .82,\ F(8, 112) = 1.50,\ p > .05,\ \eta = .09$. We further decomposed the 2-way interaction Picture $\times$ Emotion, by conducting a (4) series of t-tests: Attesting to the validity of the stimulus materials, participants rated both AR and CORE higher in disgust than FEAR, $t(61) = 12.6,\ p < .001$ and $t(61) = 10.3,\ p < .001$, respectively. When directly comparing both types of disgust categories it appeared that AR elicited slightly higher disgust and also higher fear ratings than CORE, $t(61) = 3.5,\ p = .001$ and $t(61) = 9.1,\ p < .001$, respectively.

In order to verify if PEN stimuli were rated differently across groups and to examine how this related to both neutral contrasts (BOD and NEU), we conducted our 2nd manipulation test (ii) a 3 Picture (PEN, BOD, NEU) $\times$ 3 Emotion (pleasure, disgust, fear) $\times$ 3 Group (Vaginismus, Dyspareunia, Controls) mixed between-within subject ANOVA. A significant interaction was noted for Picture $\times$ Emotion Wilk's $\lambda = .27,\ F(4, 56) = 38.7,\ p < .001, \eta = .73$ indicating that the pattern of ratings generally varied across stimuli with relatively high pleasure ratings for BOD and NEU together with relatively high disgust and fear ratings for PEN. This pattern varied across groups as evidenced by the significant 3-way (Emotion $\times$ Picture $\times$ Group) interaction (see also Table 7.1) Wilk's $\lambda = .70,\ F(8, 112) = 2.8,\ p < 0.008,\ \eta = .17$. To further investigate the 3-way interaction, we investigated the 2-way interaction

Emotion*Group for each of the 3 stimuli categories (NEU, BOD, PEN).

Table 7.1: Subjective evaluation of the still stimuli

| | Vaginsmus $N = 20$ | | | Dyspareunia $N = 21$ | | | Healthy Controls $N = 21$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dimensions of emotions elicited | | | | | | | | |
| | Disgust | Fear | Pleasure | Disgust | Fear | Pleasure | Disgust | Fear | Pleasure |
| Stimuli | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ | $m(sd)$ |
| CORE | 79(15) | 25(28) | 3(4) | 82(15) | 27(29) | 3(4) | 79(14) | 27(19) | 5(7) |
| A-R | 82(19) | 38(36) | 5(6) | 87(14) | 47(34) | 4(5) | 87(17) | 56(29) | 4(7) |
| FEAR | 50(28) | 68(24) | 8(8) | 47(27) | 75(24) | 7(9) | 40(27) | 71(20) | 5(6) |
| **PEN** | **42(33)** | **28(26)** | **22(18)** | **44(31)** | **21(23)** | **23(25)** | **26(26)** | **10(12)** | **37(25)** |
| BOD | 1(2) | 3(5) | 57(23) | 3(4) | 3(6) | 60(22) | 1(1) | 2(2) | 57(19) |
| NEU | .3(.3) | .4(.4) | 56(28) | .3(.4) | .5(.5) | 46(25) | .6(.6) | .4(.5) | 32(27) |

Y-axis, the stimuli presented on a visual analogue scale (VAS) off-magnet, X-axis, emotions elicited on 3 dimensions (i.e., disgust, fear, pleasure) for the three groups (i.e., vaginismus, dyspareunia and healthy controls). DIS, core disgust elicitors, A-R, animal-reminder disgust elicitors; FEA, fear related stimuli; PEN, explicit sexual penetration stimuli; BOD, neutral bodies; NEU, neutral objects. The VAS had a scale of 0 to 100, with high score indicating higher affect (pleasure/disgust/fear).

For PEN stimuli a significant 2-way interaction was observed (Wilk's $\lambda = .84,\ F(4, 116) = 2.7,\ p < 0.03,\ \eta = .09$), indicating that the pattern of ratings differed across groups with both clinical groups showing trends of higher ratings on the dimension of disgust and threat as well as less pleasure, when compared to controls (see Table 7.1). To further confirm that this interaction indeed is driven by the difference between the clinical versus controls, we subjected PEN to 2 Group (clinical vs. control) $\times$ 3 Emotion (disgust, fear, pleasure), which in line with expectations reached significance in the predicted direction (Wilk's $\lambda = .86,\ F(2, 59) = 4.6,\ p < 0.01,\ \eta = .14$).

For BOD stimuli, the two-way interaction did not reach significance indicating that the pattern was overall similar for all groups (Wilk's $\lambda = .96,\ F(4, 116) = 0.54$). For NEU the Emotion $\times$ Group did reach significance (Wilk's $\lambda = .75,\ F(4, 116) = 4.4,\ p < 0.01$); to decompose the interaction further we conducted a 3 one-way ANOVAs separately for each emotion-dimension. Groups did not differ on the emotion of disgust and fear ($p > 0.16$), yet showed a differential pattern regarding their pleasure ratings $F(2, 59) = 4.0,\ p < 0.02$). Post hoc comparisons showed that the only the contrast between vaginismus and controls reached significance, indicating that the vaginismus group rated the NEU stimuli as more pleasurable than the controls ($p < .001$).

### 7.3.2 fMRI results

*Visual processing of penile-vaginal intercourse main effects.* Women with vaginismus are unable to have penile vaginal intercourse. Our main interest therefore pertained to the PEN>BOD contrast, which was assumed to best capture brain activity related to the visual processing of couples having penile-vaginal intercourse. Over subjects and groups significant ($p < 0.05$, FWE corrected) activity was found in widespread, bilateral occipitotemporal and occipitoparietal areas, the latter reaching up to the superior parietal lobule. More rostral in the brain, activity was found in bilateral precentral gyrus corresponding to ventral premotor cortex. Substantial subcortical activity was found, centered posteriorly on the pulvinar of the thalamus and the dorsal midbrain, and anteriorly on the hypothalamus and basal forebrain (see Table 7.2). Within the separate subject groups the overall picture was similar. Although, globally the women with no penetration problems activated subcortical areas and premotor cortex more convincingly than the clinical groups did, this did not approach the conventional level of significance (see Table 7.2).

*Group differences in processing of images of penile-vaginal intercourse.* No significant group differences (p<0.05, FWE corrected) were found for the (PEN > NEU - BOD > NEU) contrast, or for any of the other contrasts [(CORE > NEU - BOD > NEU), (AR > NEU - BOD > NEU), (FEAR > NEU - BOD > NEU).

*Shared brain activity from viewing penetration and aversive images.* Over groups and subjects there was significant ($p < 0.05$, FWE corrected for multiple comparison) shared activity between (PEN > NEU - BOD > NEU) activation maps and (CORE > NEU - BOD > NEU) and (AR > NEU - BOD > NEU) activation maps. Conjugated activity for PEN- and AR-related activity was most pronounced. It was found in widespread, bilateral occipitotemporal and occipitoparietal areas reaching up to the superior parietal lobule. The ventral premotor cortex showed shared activity bilaterally. The same was true for the pulvinar of the thalamus, the midbrain and the hypothalamus/basal forebrain (see Table 7.3). Conjugated activity for PEN- and CORE-related activity was far less pronounced, especially in occipitotemporal and occipitoparietal areas. Subcortical shared effects were confined to the midbrain and hypothalamus. Conjugated activity for PEN-and FEAR-related activation maps was virtually absent, with only one small cluster of shared activity in left occipitotemporal cortex (see Table 7.3).

Within each subject group, only the activity shared between PEN- and AR stimuli reached significance. Healthy subjects had more voxels of shared activity than did the other groups, particularly in ventral premotor and occipitotemporal cortical areas but also in the right posterior thalamus and in the midbrain (see Table 7.4).

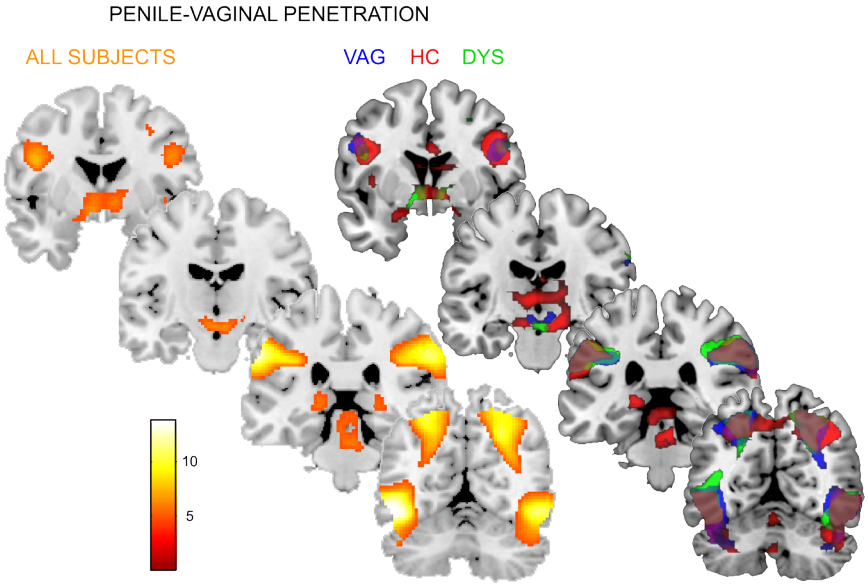


Figure 7.1: Central processing of images of penile-vaginal intercourse (PEN-related activity). The left part of the figure depicts the activity over groups and subjects, thresholded at $p < 0.05$, FWE corrected for multiple comparisons. The right side of the picture depicts activity patterns for the three $p < 0.05$, FWE corrected for multiple comparisons

## 7.4 Discussion

In this study it was tested if women with penetration disorders (particularly women with primary/lifelong vaginismus) would have stronger convergence in their responses toward sexual (penile-vaginal) penetration and prototypical disgust-eliciting stimuli. The major results can be summarized as follows: there was a large overlap between disgust and penetration stimuli across the three groups (vaginismus, dyspareunia, controls). This general overlap between penetration- and disgust-induced brain activation was most pronounced for AR disgust.

Attesting to the validity of the stimulus materials, both disgust categories (i.e., AR, CORE) were rated as highly disgusting, and the disgust ratings were higher for the disgust stimuli than for the FEAR and NEU (neutral-contrast) stimuli. The finding that the disgust stimuli also elicited low levels of fear (in addition to disgust) is consistent with the dominant disease-avoidance explanation of disgust (Curtis et al., 2011; Oaten et al., 2009). Namely, that the prospect of being contaminated by pathogens (either via incorporating toxic/food items, or via close physical contact with people who carry a transmittable disease), will logically also elicit fear of con-

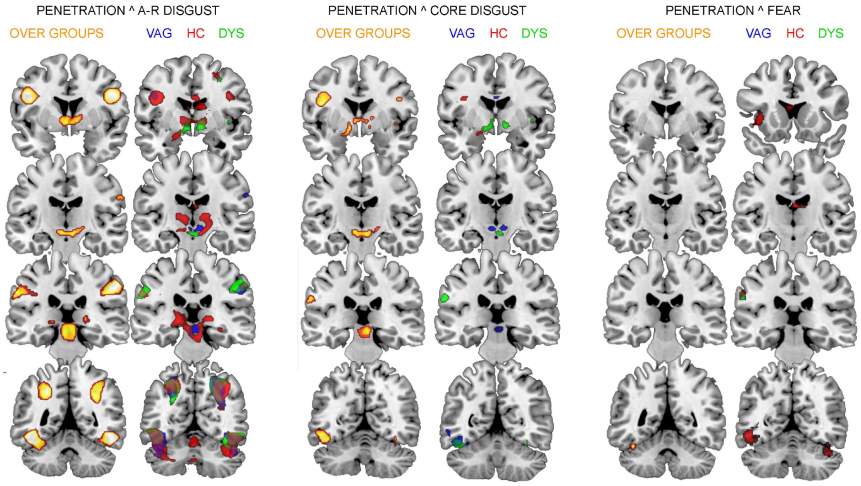


Figure 7.2: PEN-related brain responses overlap most prominently with AR-related brain responses. Results are shown from the conjunction analyses [(PEN > NEU - BOD > NEU) ∧ (A-R > NEU - BOD > NEU)], [(PEN > NEU - BOD > NEU) ∧ (CORE > NEU - BOD > NEU)] and [(PEN > NEU - BOD > NEU) ∧ (FEAR > NEU - BOD > NEU)]. The left side of each column (yellow shading) depicts the shared activity over subjects and groups (thresholded at $p < 0.05$, FWE corrected for multiple comparisons). The right side of each column depicts the shared activity within the groups. The left part of the figure depicts the activity over groups and subjects, thresholded at $p < 0.05$, FWE corrected for multiple comparisons. The right side of the picture depicts shared activity patterns within the three separate groups (healthy controls, red; vaginismus, blue; dyspareunia, green), thresholded at $p < 0.001$ uncorrected for display purposes. Overlap is indicated by purple or taupe color. VAG, vaginismus; DYS, dyspareunia; HC, healthy controls.

tamination and/or of getting inflicted by a disease (Verwoerd et al., 2013). The subjective ratings also showed some differences in participants' appreciation of CORE and AR disgust stimuli, in that AR elicited both stronger disgust and stronger fear than CORE did. It needs mention that both disgust types are assumed to represent pathogen disgust (Tybur et al., 2013). Yet, the features of deformed body parts that make part of AR disgust elicitors, may not only represent a stronger contamination potency than CORE disgust elicitors such as food items and body waste products, but also more directly represent the (threatening) consequences of actually getting contaminated (by the pathogens responsible for the depicted condition). The subjective ratings of the disgust stimuli were similar for all groups. Nevertheless, with regards to the disorder specific stimuli (i.e., PEN), the pattern of ratings varied across groups. The clinical groups (i.e., dyspareunia, vaginismus) rated the PEN stimuli as less pleasurable and both more disgusting and more threatening, compared to

women with no sexual problems, which is consistent with previous work (Cherner and Reissing, 2013; Huijding et al., 2011; Borg et al., 2010; Brauer et al., 2007).

In a previous report of this fMRI-project that was restricted to women with no sexual complaints (see Chapter 6), we already demonstrated that core disgust and PEN stimuli generally captured large similarities in their respective neural reactivity (Borg, de Jong and Georgiadis, 2013) which is consistent with previous work (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). The present findings extend this earlier report in two major ways: First, it shows that this convergence in brain-responses between PEN and (non-sex) disgust elicitors is not restricted to women with no penetration related problems, but is neither more pronounced in the clinical groups (i.e., vaginismus or dyspareunia). Second, it showed that across groups, the processing of PEN stimuli shared more similarities with the processing of AR-disgust in deep brain areas (including the pulvinar of the thalamus, the midbrain, and the basal forebrain) than with the processing of core-disgust elicitors. Whereas this shared activity was virtually absent when compared to the processing of the fear-eliciting stimuli.

As argued above, core disgust elicitors are predominantly associated with contamination by oral related ingestions, while AR disgust seems more related to a bodily type of pathogen transmission. The latter type of transmission of pathogens seems most closely related to how penile-vaginal penetration could give rise to pathogen transmission. The finding that the convergence with PEN processing was especially strong for AR stimuli might thus be explained by the shared pathway of potential pathogen transmission through body products and body apertures.

More generally, the convergence of disgust and PEN is consistent with the idea that disgust might be involved in sexual penetration and may contribute to the problems in penetration disorders. Yet, the finding that also in women with no penetration problems there seems to be a similarly strong convergence flips the question - from 'is disgust involved in vaginismus?' to 'how do healthy women succeed in having pleasurable sex at all, in light of the strong disgust component actually involved in sex?' (de Jong et al., 2013).

In this line of reasoning, it could be speculated that women may generally have an ambivalent response to penetration, because on the one hand, avoidance may be triggered in order to prevent the contamination by pathogen transmission, whereas on the other hand approach might be triggered to support procreation and pleasure (Stevenson et al., 2011; de Jong et al., 2013). In the same vein, this negative/ambivalent response could also be related to the fact that penetration per se is not synonymous with orgasm in women (vs. clitoris stimulation). When considering that this study was conducted in a lab (scanner) context, this negative response is perhaps particularly pronounced - especially when sexual readiness is absent (Borg

and de Jong, 2012).

Moreover, it needs to be mentioned, that people were just passively viewing the presented stimuli and were not primed to a particular evaluative mode; this might also be relevant for the understanding of the present pattern of results. Notably, in previous research in which it was explicitly asked from participants to categorise PEN stimuli on a dimension of disgust-hot, specifically women with penetration disorders (both vaginismus and dyspareunia) displayed strong PEN-disgust associations, whereas women with no sexual complaints showed relatively strong PEN-'hot' associations (Borg et al., 2010). Consistent with such an explanation, a differential pattern between controls and women with penetration disorders was evident for the current subjective ratings - that were obviously done in an evaluation mode (Huijding et al., 2011; Borg et al., 2010).

It has recently been put forward that sexual arousal may be a critical factor that can switch the default disgust response to a sexual appetitive/approach response (Stevenson et al., 2011). Accordingly, it has been demonstrated that when sexually aroused, women with no sexual complaints rated sex-related (previously considered disgusting) stimuli as less disgusting, compared to women who were either generally aroused or in a neutral mood. These sexually aroused women also showed reduced avoidance behaviour (Borg and de Jong, 2012). Following this, one could speculate that perhaps the sexual complaints in vaginismus could be explained by assuming that they have more difficulty to overrule the default sex-disgust response. Relevant to this, it was found that in contrast to asymptomatic women, women with vaginismus continued to show physiological signs of disgust (as measured via the facial levator muscle), while watching an erotic movie that is generally successful in eliciting sexual arousal (Borg et al., 2010; de Jong et al., 2013). Thus the absence of an evaluation mode and/or the absence of sexual arousal might help explain why even women with no penetration related problems, showed a strong convergence in their brain response towards AR and PEN. This could perhaps be detangled by eliciting sexual arousal in the scanner before the actual exposure of PEN stimuli.

In conclusion, this paper is a first attempt to tap in the underpinnings of the neural correlates of negative emotional responses toward disorder specific stimuli (i.e., PEN). The earlier reported convergence in the brain-activity between PEN and disgust in women with no penetration problems seems not to be more pronounced in women with penetration disorders. In fact, one could speculate that this overlap seems to reflect a default negative/disgust response towards penetration stimuli across all women, perhaps particularly so in the absence of sexual readiness. A critical next step would be to examine the processing of PEN stimuli in women with and without sexual dysfunction following sexual arousal induction.

Table 7.2: Brain processing of PEN

| Penetration > Neutral Bodies | | OVER GROUPS | | | | | HEALTHY | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | | | | | | |
| inferior temporal gyrus | $L$ | 7431 | −50 | −62 | −10 | 13.66 | 874 | −52 | −60 | −10 | 8.18 |
| inferior temporal gyrus | $R$ | lm | 50 | −56 | −12 | | 3604 | 48 | −58 | −12 | 7.26 |
| inferior occipital gyrus | $R$ | | | | | | lm | 38 | −86 | −6 | |
| inferior occipital gyrus | $L$ | | | | | | | | | | |
| precuneus | | | | | | | 78 | 0 | −52 | 54 | 5.49 |
| **occipitoparietal** | | | | | | | | | | | |
| supramarginal gyrus | $L$ | $lm$ | −60 | −30 | 34 | | $lm$ | −60 | −26 | 34 | |
| supramarginal gyrus | $R$ | 8759 | 58 | −26 | 36 | 12.31 | | | | | |
| inferior parietal lobule | $L$ | | | | | | | | | | |
| inferior parietal lobule | $R$ | | | | | | | | | | |
| sup occ gyr/sup par lobule | | $lm$ | 24 | −66 | 44 | | $lm$ | 28 | −78 | 26 | |
| sup occ gy/sup par lobule | | | | | | | | −22 | −66 | 48 | 6.94 |
| **frontal** | | | | | | | | | | | |
| | $R$ | 648 | 50 | 6 | 26 | 8.58 | 127 | 50 | 4 | 24 | 5.3 |
| precentral gyr/ | $L$ | 415 | −46 | 2 | 28 | 7.87 | 72 | −46 | 2 | 28 | 5.5 |
| premotor cortex | $R$ | 105 | 32 | −4 | 50 | 5.89 | | | | | |
| | $L$ | 88 | −24 | −6 | 46 | 5.49 | 21 | −28 | −8 | 46 | 4.96 |
| **(para)limbic** | | | | | | | | | | | |
| insula | $R$ | 21 | 42 | −4 | −4 | 5.26 | | | | | |
| **subcortical** | | | | | | | | | | | |
| thalamus (posterior) | $L$ | 148 | −18 | −30 | 2 | 5.73 | 55 | −16 | −26 | 6 | 5.14 |
| thalamus (posterior) | $R$ | 58 | 22 | −30 | 0 | 5.28 | 15 | 20 | −24 | 4 | 4.99 |
| midbrain | $L$ | 1262 | −4 | −24 | −14 | 6.46 | 19 | −8 | −22 | −12 | 4.92 |
| midbrain | $R$ | lm | 2 | −16 | −12 | | 8 | 10 | −20 | −14 | 4.86 |
| hypothalamus/ | $L$ | lm | −6 | 0 | −8 | | 4 | −4 | −4 | 2 | 4.63 |
| basal forebrain/vp | | | | | | | | | | | |
| cerebellar hemisphere | | | | | | | 5 | −42 | −70 | −32 | 4.79 |
| cerebellar hemisphere | | | | | | | 12 | 44 | −64 | −28 | 4.72 |

Central processing of images of penile-vaginal intercourse (PEN-related activity). PEN activation maps (resulting from contrasts with neutral objects, PEN > NEU) were compared with activation maps related to processing of images of bodies interacting neutrally (BOD > NEU). $k$, number of voxels; lm, local maximum. All clusters are $p < 0.05$, FWE corrected for multiple comparisons.

| Penetration > Neutral Bodies | | DYSPAREUNIA | | | | | VAGINISMUS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | | | | | | |
| inferior temporal gyrus | $L$ | 661 | −46 | −64 | −10 | 8.26 | 1871 | −44 | −64 | −12 | 7.79 |
| inferior temporal gyrus | $R$ | 483 | 42 | −64 | −14 | 6.88 | 660 | 50 | −56 | −12 | 7.65 |
| inferior occipital gyrus | $R$ | lm | 40 | −82 | 12 | 6.69 | 3449 | 40 | −78 | 2 | 7.78 |
| inferior occipital gyrus | $L$ | 66 | −34 | −88 | −4 | 6.59 | lm | −34 | −86 | −6 | |
| precuneus | | lm | 36 | −88 | −2 | | | | | | |
| **occipitoparietal** | | | | | | | | | | | |
| supramarginal gyrus | $L$ | | lm | −58 | −30 | 36 | lm | −60 | −32 | 36 | |
| supramarginal gyrus | $R$ | 1710 | 58 | −24 | 36 | 8.16 | | | | | |
| inferior parietal lobule | $L$ | 1342 | −38 | −38 | 38 | 8.17 | 1509 | −38 | −46 | 46 | |
| inferior parietal lobule | $R$ | lm | 34 | −38 | 40 | | lm | 34 | −42 | 46 | |
| sup occ gyr/sup par lobule | | lm | 22 | −64 | 46 | | | | | | |
| sup occ gy/sup par lobule | | 92 | −28 | −68 | 24 | 5.4 | lm | −28 | −60 | 54 | |
| **frontal** | | | | | | | | | | | |
| | $R$ | 23 | 54 | 6 | 28 | 4.99 | 103 | 50 | 6 | 26 | 5.29 |
| precentral gyr/ | $L$ | | | | | | | | | | |
| premotor cortex | $R$ | | | | | | | | | | |
| | $L$ | | | | | | | | | | |
| **subcortical** | | | | | | | | | | | |
| thalamus (posterior) | $L$ | | | | | | | | | | |
| thalamus (posterior) | $R$ | | | | | | | | | | |
| midbrain | $L$ | | | | | | | | | | |
| midbrain | $R$ | | | | | | | | | | |
| hypothalamus/ | $L$ | 10 | −8 | 2 | −6 | 5.04 | | | | | |
| basal forebrain/vp | | | | | | | | | | | |
| cerebellar hemisphere | | | | | | | 5 | −46 | −66 | −32 | 4.74 |
| cerebellar hemisphere | | | | | | | | | | | |

...continuation of Table 7.2

Table 7.3: Penetration and disgust induced brain activations

| OVER GROUPS | | Penetration ∧ Core disgust | | | | | Penetration ∧ A-R disgust | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | | | | | | |
| inferior temporal gyrus | $L$ | 555 | −46 | −54 | −16 | 6.62 | 4520 | −46 | −60 | −14 | 12.66 |
| inferior temporal gyrus | $R$ | 20 | 34 | −56 | −16 | 4.87 | | | | | |
| inferior occipital gyrus | $L$ | 14 | −32 | −88 | −6 | 5.04 | | | | | |
| inferior occipital gyrus | $R$ | 23 | 34 | −88 | −4 | 5.50 | lm | −34 | −88 | 2 | |
| **occipitoparietal** | | | | | | | | | | | |
| supramarginal gyrus | $L$ | 77 | −62 | −24 | 28 | 5.85 | lm | −24 | −70 | 34 | |
| sup occ gyr/sup par lobule | | | | | | | lm | 24 | −66 | 44 | |
| **frontal** | | | | | | | | | | | |
| | $R$ | 41 | 46 | 4 | 26 | 5.22 | 547 | 50 | 6 | 26 | 8.58 |
| precentral gyr/ | $L$ | 217 | −44 | 2 | 22 | 6.49 | 415 | −46 | 2 | 28 | 7.87 |
| premotor cortex | $R$ | | | | | | 48 | 30 | −6 | 48 | 5.38 |
| **(para)limbic** | | | | | | | | | | | |
| insula | $R$ | 21 | 42 | −4 | 4 | 5.26 | 20 | 42 | −4 | 4 | 5.26 |
| middle cingulate cortex | $R$ | | | | | | 9 | 2 | −2 | 28 | 4.78 |
| hippocampus | $R$ | 9 | 32 | −32 | −8 | 4.89 | 9 | 32 | −22 | −8 | 4.89 |
| **subcortical** | | | | | | | | | | | |
| thalamus (posterior) | $R$ | | | | | | 48 | 22 | −30 | 0 | 5.28 |
| thalamus (posterior) | $L$ | | | | | | 36 | −20 | −32 | 0 | 5.28 |
| midbrain | $L$ | lm | −2 | −24 | −10 | | 594 | −4 | −24 | −14 | 6.46 |
| midbrain | $R$ | 541 | 6 | −22 | −12 | 6.15 | lm | 4 | −26 | −8 | |
| hypothalamus/ basal forebrain/vp | $L$ | lm | −6 | 0 | −8 | | 317 | −6 | 2 | −2 | 5.92 |
| hypothalamus/ basal forebrain | $R$ | | | | | | lm | 6 | 2 | 0 | |

| OVER GROUPS | | Penetration ∧ Fear | | | | |
|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | |
| inferior temporal gyrus | $L$ | 15 | −40 | −50 | −24 | 4.84 |

Shared activity between PEN-related brain responses and brain responses related to aversive stimuli. Results are shown from the conjunction analyses [(PEN > NEU - BOD > NEU) ∧ (CORE > NEU - BOD > NEU)], [(PEN > NEU - BOD > NEU) ∧ (AR > NEU - BOD > NEU)] and [(PEN > NEU - BOD > NEU) ∧ (FEAR > NEU - BOD > NEU)]. $k$, number of voxels; lm, local maximum. All clusters are $p < 0.05$, FWE corrected for multiple comparisons.

Table 7.4: PEN- and AR-related processing overlap

| Penetration ∧ A-R disgust | | HEALTHY | | | | | DYSPAREUNIA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | | | | | | |
| inferior temporal gyrus | $L$ | 620 | −48 | −58 | −14 | 7.16 | 410 | −48 | −62 | −12 | 7.97 |
| inferior temporal gyrus | $R$ | lm | 48 | −56 | −14 | 6.66 | 315 | 40 | −64 | −16 | 6.53 |
| inferior occipital gyrus | $L$ | lm | −32 | −88 | −4 | | 59 | −34 | −90 | 0 | 5.99 |
| inferior occipital gyrus | $R$ | 1337 | 38 | −86 | −6 | 6.87 | 168 | 36 | −88 | −2 | 6.43 |
| **occipitoparietal** | | | | | | | | | | | |
| supramarginal gyrus | $L$ | 95 | −62 | −24 | 28 | 5.85 | | | | | |
| supramarginal gyrus | $R$ | | | | | | 103 | 52 | −26 | 40 | 6.25 |
| sup occ gyr/sup par lobule | $L$ | 553 | −22 | −66 | 48 | 6.35 | 91 | −26 | −62 | 46 | 5.26 |
| sup occ gyr/sup par lobule | $R$ | lm | 24 | −68 | 44 | | 336 | 22 | −64 | 46 | 6.34 |
| inferior parietal lobule | $L$ | 29 | −40 | −40 | 32 | 5.09 | 65 | −38 | −38 | 38 | 5.34 |
| inferior parietal lobule | $R$ | 13 | 46 | −38 | 38 | 4.83 | | | | | |
| **frontal** | | | | | | | | | | | |
| precentral gyr/premotor cortex | $R$ | 107 | 50 | 4 | 24 | 5.3 | 23 | 54 | 6 | 28 | 4.99 |
| precentral gyr/premotor cortex | $L$ | 63 | −46 | 2 | 28 | 5.5 | | | | | |
| **subcortical** | | | | | | | | | | | |
| thalamus (posterior) | $L$ | | | | | | | | | | |
| thalamus (posterior) | $R$ | 6 | 18 | −24 | 2 | 4.76 | | | | | |
| midbrain | $L$ | | | | | | | | | | |
| midbrain | $R$ | 4 | 10 | −20 | −14 | 4.8 | | | | | |
| **Penetration ∧ Core disgust** | | | | n.s | | | | | n.s | | |
| **Penetration ∧ Fear** | | | | n.s | | | | | n.s | | |

PEN-related and AR-related processing overlap most prominently: Within-group effects. Results from the conjunction analysis [(PEN > NEU - BOD > NEU) ∧ (AR > NEU - BOD > NEU)] are listed per group. $k$, number of voxels; lm, local maximum. All clusters are $p < 0.05$, FWE corrected for multiple comparisons.

| Penetration ∧ A-R disgust | | VAGINISMUS | | | | |
|---|---|---|---|---|---|---|
| | | $k$ | $x$ | $y$ | $z$ | $T$ |
| **occipitotemporal** | | | | | | |
| inferior temporal gyrus | $L$ | 404 | −46 | −58 | −14 | 6.94 |
| inferior temporal gyrus | $R$ | 281 | 46 | −52 | −14 | 7.2 |
| inferior occipital gyrus | $L$ | | | | | |
| inferior occipital gyrus | $R$ | lm | 38 | −80 | 6 | |
| **occipitoparietal** | | | | | | |
| supramarginal gyrus | $L$ | | | | | |
| supramarginal gyrus | $R$ | | | | | |
| sup occ gyr/sup par lobule | $L$ | | | | | |
| sup occ gyr/sup par lobule | $R$ | 971 | 26 | −66 | 40 | 6.39 |
| inferior parietal lobule | $L$ | | | | | |
| inferior parietal lobule | $R$ | | | | | |
| **frontal** | | | | | | |
| precentral gyr/premotor cortex | $R$ | 18 | 50 | 6 | 26 | 5.01 |
| precentral gyr/premotor cortex | $L$ | | | | | |
| precentral gyr/premotor cortex | $R$ | | | | | |
| precentral gyr/premotor cortex | | | | | | |
| **subcortical** | | | | | | |
| thalamus (posterior) | $L$ | | | | | |
| thalamus (posterior) | $R$ | | | | | |
| midbrain | $L$ | | | | | |
| midbrain | $R$ | | | | | |
| **Penetration ∧ Core disgust** | | | | n.s | | |
| **Penetration ∧ Fear** | | | | n.s | | |

...continuation of Table 7.4

## Section IV

# Reciprocity of disgust and sexual arousal

# Chapter 8

# Feelings of disgust and disgust-induced avoidance weaken with sexual arousal


**Abstract**

*Sex and disgust are basic, evolutionary relevant functions that are often construed as paradoxical. In general the stimuli involved in sexual encounters are, at least out of context strongly perceived to hold high disgust qualities. Saliva, sweat, semen and body odours are among the strongest disgust elicitors. This results in the intriguing question of how people succeed in having pleasurable sex at all. One possible explanation could be that sexual engagement temporarily reduces the disgust eliciting properties of particular stimuli or that sexual engagement might weaken the hesitation to actually approach these stimuli. Participants were healthy women (n=90) randomly allocated to one of three groups: the sexual arousal, the non sexual positive arousal, or the neutral control group. Film clips were used to elicit the relevant mood state. Participants engaged in 16 behavioural tasks, involving sex-related (e.g., lubricate the vibrator) and non sex-related (e.g., take a sip of juice with a large insect in the cup) stimuli, to measure the impact of sexual arousal on feelings of disgust and actual avoidance behaviour. The sexual arousal group rated the sex-related stimuli as less disgusting compared to the other groups. A similar tendency was evident for the non sex disgusting stimuli. For both the sex and non sex related behavioural tasks the sexual arousal group showed less avoidance behaviour (i.e., they conducted the highest percentage of tasks compared to the other groups). This study has investigated how sexual arousal interplays with disgust and disgust eliciting properties in women, and has demonstrated that this relationship goes beyond subjective report by affecting the actual approach to disgusting stimuli. Hence, this could explain how we still manage to engage in pleasurable sexual activity. Moreover, these findings suggest that low sexual arousal might be a key feature in the maintenance of particular sexual dysfunctions.*



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## 8.1 Introduction

*'A man, who will kiss a pretty girl's mouth passionately, may perhaps be disgusted by the idea of using her tooth-brush'. Sigmund Freud*

Sex as a procreation stance and disgust as a defensive mechanism, are both basic, evolutionary relevant functions, yet their relationship is paradoxical and possibly obstructive. Disgust has been argued to be evolved as a defensive mechanism to protect the organism from external contamination (Curtis et al., 2004, 2011). Consequently, the main organs or body parts that are involved in this defensive mechanism are known to lie on the border of the body. Accordingly, the mouth and vagina are amongst the body parts that show strongest disgust sensitivity, possibly due to their aperture and higher perceived risk of contamination (Rozin et al., 1995). In addition, the stimuli involved in sexual encounters are in general (at least out of context) strongly perceived to hold high disgust qualities, with saliva, sweat, semen and body odours qualifying among the strongest disgust elicitors (Rozin et al., 1995). Clearly then, disgust may be an important interfering factor in sexual activity which may help to explain the mechanisms involved in sexual dysfunction (Borg et al., 2010; de Jong et al., 2009).

The finding that many of the strongest disgust eliciting stimuli are also involved in sex (e.g., saliva, and sweat) may not only help explain how disgust may be involved in sexual dysfunction, but it also raises the critical question of how people succeed in having pleasurable sex at all. One possible explanation could be that sexual engagement temporarily reduces the disgust eliciting properties of particular stimuli. Another hypothesis could be that sexual engagement might weaken the hesitation to approach disgust eliciting stimuli. Consequently, this would motivate further approach behaviour, in spite of the unchanged disgust properties of the stimuli. Alternatively, both mechanisms could act in concert. In line with the above, another possible explanation is that the disgust properties of specific stimuli might more readily decrease (i.e., habituate), when being sexually aroused during actual exposure to these disgusting stimuli.

Germane to this, a recent experimental study investigated whether sexual arousal may indeed reduce the disgust properties of specific stimuli in male participants. To elicit sexual arousal, the experimental group watched erotic female images. These male students were then exposed to a series of sex-related and non sex-related disgust elicitors that were drawn from various sensory modalities (i.e., visual, tactile, auditory, and olfactory). For example as tactile disgust elicitors, participants were asked to place their dominant hand through a small opening (so the content was not visible) in a bucket containing either four lubricated condoms (sex-related) or cold pea and ham soup (non sex-related) while their nostrils were

blocked with cotton wool plugs to prevent the perception of any relevant smells. Interestingly, participants in the experimental group subjectively reported being less disgusted by sex-related disgust elicitors than participants in the control conditions who were not sexually aroused (Stevenson et al., 2011). Consistent with this, a correlational study showed that both men and women reported less disgust after watching an erotic film when they were more sexually aroused (Koukounas and McCabe, 1997). Similarly, other studies have shown that sexual motivation can distort judgements about the risk of contracting sexually transmitted disease, and sexual arousal has been shown to have a strong impact on decision making (Ditto et al., 2006). In a similar vein it has been demonstrated that men when sexually aroused reported that they would consider having sex with a woman who is extremely fat, which contrasted their perceptions and reported repulsion when they were not sexually engaged (Ariely and Loewenstein, 2006). Therefore one can argue that sexual arousal may attenuate all kinds of mechanisms that may act in a way to avoid particular sexual behaviours or stimuli - be it general repulsion, moral borders (e.g., having sex with a 12 year old) or contamination risk (e.g., condom use). Thus, sexual arousal may influence mechanisms that normally help people avoid certain (disgusting) stimuli.

Although previous findings seem to partially elucidate why people still approach particular stimuli and engage in sex, thus far these findings are restricted to subjective feelings or self-report measures about imagined situations (Stevenson et al., 2011; Koukounas and McCabe, 1997; Ditto et al., 2006; Ariely and Loewenstein, 2006). It would therefore be important to further investigate whether experimentally induced sexual arousal is not only successful in reducing deliberately reported disgust, but also people's willingness to actually approach particular initially disgusting stimuli. The avoidance response is significant because disgust may create distance from the disgusting stimuli and thus interfere with sexual behaviours. It could very well be that behaviour is modulated by sexual arousal and consequently weakens the tendency to avoid. For instance, a reduction of subjective disgust in the condition of sex or a sexual encounter could follow merely by being in contact with a particular stimulus. Besides, these earlier findings on the impact of sexual arousal on the disgust-eliciting properties of particular sexual stimuli were predominantly restricted to men (Stevenson et al., 2011). Given the evolutionary differential roles of men and women, women's higher sensitivity to disgust (Fessler et al., 2003; Haidt et al., 1994) and their higher vulnerability to infections (Salvatore et al., 2011), it would be interesting to investigate whether these findings are also robust in a female sample.

Therefore, the present study was designed to test whether in women also a sexual arousal induction would attenuate disgust in response to sex-related disgusting

stimuli. Importantly, we not only examined the influence of sexual arousal on the subjective feelings of disgust but also tested whether sexual arousal would facilitate participants' actual approach towards disgusting stimuli. Moreover, in order to test whether this reduction in disgust properties would be restricted to sexual stimuli or would represent a more general phenomenon that applies to disgusting stimuli in general, we also included generally disgusting stimuli that do not directly refer to sex (i.e., non sex-related).

In addition, previous evidence suggested that disgust is not a unitary emotion but that there are different subtypes. Current research suggest that four different categories of disgusting stimuli can be differentiated, namely core, animal-reminder, contamination and moral disgust stimuli (Curtis et al., 2011; Rozin et al., 2008). It has been argued that disgust originated from oral distaste and has over time evolved to include other self-protection systems and boundaries (Rozin et al., 2008; Borg and de Jong, 2012). Subsequently, disgust is considered a basic response to a wide range of stimuli that may signal unhygienic contamination and the potential for disease (Rozin et al., 2008). Therefore, we decided to include behavioural tasks consisting of stimuli from the four disgust subtypes for more complete coverage of this basic emotion: core disgust (e.g., eat a biscuit with a living worm on it), moral disgust (e.g., put on a shirt of a paedophile, worn during sexual acts), animal-reminder disgust (e.g., hold the bone in your hands of a dead animal) and contamination disgust (e.g., place a used underpants/knickers in a laundry bag) (Olatunji et al., 2008). We measured participants' subjective and behavioural responses in the context of these four subtypes of disgust.

In order to test if sexual arousal attenuates the disgust properties of particular stimuli, we used an erotic film to induce sexual arousal. To control for the influence of mere positive arousal we also included a more generally arousing film clip (positive arousal), whereas a neutral film clip was added in order to serve as the baseline condition.

## 8.2 Method

### 8.2.1 Participants

Healthy female students ($n = 90$, mean age $= 23.12$; SD $= 1.99$) were recruited at the University of Groningen via advertisement on university premises. The experiment was advertised as a study on 'arousing films and behavioural tasks' and no mention of either disgust or sex was made so as to minimize selection-bias. Screening was conducted with all participants in order to include only participants who had no sexual dysfunctions as the presence of sexual problems might affect participants'

responding. All participants reported moderate alcohol and nicotine consumption at most, and all denied hard drug use. All participants in this study were exclusively heterosexual. There was no significant difference between the three groups $(p > .08)$ on several socio-demographic data (e.g., mood complaints, age, education, relationship status, last sexual contact, and contraception use).

We asked potential participants to come for testing in the laboratory on a date that they could select from our internal university system that is regularly used for student recruitment at our university. We provided the participants with the standardized information about the nature of the study. Every potential individual wanted to participate in the study after they read the information. Then we randomly allocated every participant in one of the following 3 groups: a sexually aroused, a positively aroused and a neutral group. Each of the three groups consisted of 30 participants.

### 8.2.2 Mood induction stimuli material

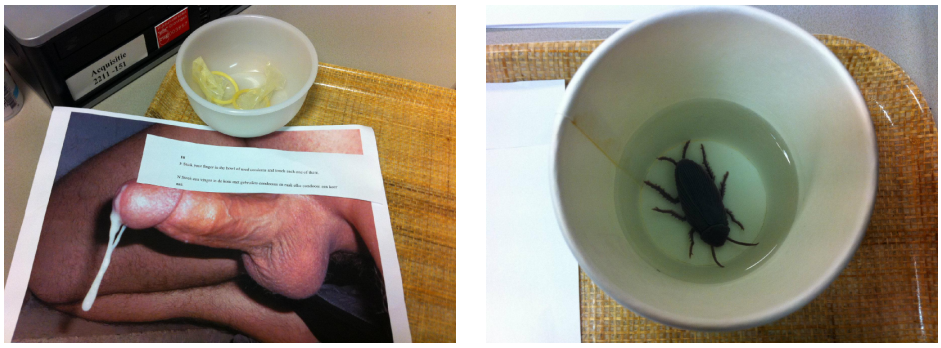
The mood-induction stimuli consisted of 3 films that were used in a between subjects design: i) a female friendly erotica ('de Gast' by Christine le Duc) that was selected to induce sexual arousal; ii) a sports/high-adrenalin arousal clip (e.g., rafting, sky diving, mountain climbing) that served to induce arousal to control for general type of positive arousal; and iii) a neutral film consisting of a train-ride exposed to different sceneries, as a baseline or reference condition. Each film clip had a duration of 35 minutes. The latter two film clips were selected by the research team themselves from a selection of publically available film clips. Each film clip was validated and pilot tested with a group of 15 female students who did not participate in the actual study. The three films selected were successful in eliciting the intended affective state (Table 8.1). These students watched the 3 selected films and were asked to rate on Visual Analogue Scales (VAS) with a length of $10cm$, how much they feel the film was eliciting a feeling of general (positive) arousal, and sexual arousal ranging from zero (not at all) to 10 (very). Table 8.1 illustrates the subjective evaluation of each stimulus-type on the dimensions of general arousal and sexual arousal. The general pattern of subjective ratings attests to the validity of the stimulus materials (Table 8.1). To examine in more detail whether the selected film material were able to elicit the intended emotion, we evaluated the relevant comparisons by means of t-tests (Table 8.1).

Table 8.1: Subjective evaluation for each dimension as a function of stimulus type.

| Emotion | Erotic | Positive arousal | Neutral |
|---|---|---|---|
| General arousal | $4.3\ (1.9)^{a,x}$ | $8.5\ (1.7)^{b,y}$ | $0.1\ (0.4)^{c}$ |
| Sexual arousal | $9.4\ (1.2)^{b,z}$ | $2.1\ (1.6)^{c,x}$ | $0.2\ (0.4)^{c}$ |

M(SD) M, mean, (SD), standard deviation. Stimulus type includes the three film categories (erotic, positive arousal and neutral film) and the dimension includes the subjective elicited mood (sexual arousal, and general arousal). Different letters in superscript (a/b/c/d) indicate significant difference between stimulus categories within a dimension ($p < .025$). For instance, the 'a' on the erotic and the 'b' on positive arousing film clip on the first row indicates that they do differ significantly from each other on the dimension of general arousal. The 2nd letter (x) applies to relevant comparisons across columns. For instance the 'x' of the erotic film clip, on the dimension of sexual arousal with the 'x' on positive arousing film on the dimension of general arousal indicates that these two do not differ significantly from each other ($p > .025$).

*Behavioural tasks* - We had 16 behavioural tasks/cues that participants were asked to conduct the requested assignment on, 4 tasks per each relevant disgust type. As mentioned in the introduction we used 4 different disgust types, namely, core, contamination, animal-reminder, and moral disgust. Appendix 8.A Table 8.4 provides a detailed description of the 16 behavioural tasks, Figure 8.1. The subcategory of core disgust included the tasks as numbered in the Appendix 8.A Table 8.4 that is 1, 2, 3, 4; moral disgust included task number 5, 6, 7, 8; animal-reminder disgust included task numbers 9, 10, 11, 12; and contamination disgust included tasks number 13, 14, 15, 16. Part of these behavioural tasks was composed of sex related stimuli or stimuli referring directly to sex, including task numbers 5, 8, 11, 15, 16. The latter two categories were initially decided on, by the research team, which was composed of a PhD student, three Master's students and a psychology professor.



(a) (b)

Figure 8.1: Behavioural tasks, 'a' representing the sex-related disgusting tasks, whereas 'b' represents the non sex-related disgusting tasks

In addition we (post hoc) invited 20 psychology students, independent of our sample to rate the stimuli (i.e., 16 behavioural tasks) on the dimension of sex relevance. The ratings were done on VAS that ranged from zero (not relevant at all) to 100 (highly relevant). We included two other dimensions (i.e., food relevant and contamination relevant) to make the main aim less obvious for participants. By and large these data confirmed our a priori division, in terms of sex relevance. The mean score of the sex-relevant tasks ($\mathrm{M} = 67.5, \mathrm{SD} = 9.8$) differed significantly from the mean score of the non sex-relevant items ($\mathrm{M} = 8.6, \mathrm{SD} = 3.1$), $t(19) = 22.9$, $p < .001$, on sex relevance. The median was 8.7 and scores ranged from $1.1$ to $41.3$ for the non sex-relevant tasks, and for the sex-relevant tasks the median was $69.6$, and scores ranged from $46.4$ to $83.9$, respectively. These descriptive statistics support the validity of the a priori assignment to sex vs. non sex category. Yet, it also shows that Task 7 differed considerably from the other items in the group of non sex-relevant, in that it was rated relatively high on sex relevance ($\mathrm{M} = 41.3$). Therefore, we decided to run the analysis with and without Task-7$^{\star}$. On the whole this produced the same pattern of results. Based on the discussions and attention the research team invested in selecting disgusting sex-relevant and non sex-relevant tasks, and because the results did not change, we decided to retain the a priori division in categories, thus leaving Task 7 (i.e., to come in contact with a shirt worn by a paedophile) in the non sex-relevant (moral) category. For details see Appendix 8.C Table 8.6

Each task consisted of four steps given by the experimenter over a speaker: i) observe the task; ii) rate the impression of the task; iii) conduct the task; and as a final step, iv) rate the task after completion. As an index of reliability, we computed Cronbach's $\alpha$ based on the subjective elicited disgust as measured by VAS (step 1). Cronbach's $\alpha$ for non sex related stimuli was $.85$;, and for sex-related stimuli $.76$, thus the reliability of both scales in terms of internal consistency was satisfactory; additionally we calculated Cronbach's $\alpha$ for the 4 disgust subtypes: core disgust stimuli $.76$; animal-reminder disgust stimuli $.74$; moral disgust stimuli $.53$; and for contamination disgust subtype $.75$. Thus, it can be concluded that the reliability of the various tasks used in this study is satisfactory, with only moral stimuli having low internal consistency.

### 8.2.3 Measures

**Disgust propensity and sensitivity scale revised (DPSS-R)**

The DPSS-R is a 16 item questionnaire that consists of two validated subscales that measure trait disgust propensity (i.e., tendency to respond with disgust to potential disgust elicitors) and trait disgust sensitivity (i.e., appraisal of experiencing disgust) (van Overveld et al., 2006). Participants read sixteen propositions on the frequency

of experiencing bodily sensations related to disgust (e.g., 'Disgusting things make my stomach turn' for propensity, and 'I think feeling disgust is bad for me, It scares me when I feel like fainting' for sensitivity), and indicated which best applied to them on a scale from 1 (never) to 5 (always). The DPSS-R has been validated and used in a number of studies (van Overveld et al., 2006) and it is the first index that measures disgust propensity and disgust sensitivity irrespective of disgust elicitors (Connolly et al., 2008). The scale has been shown to be internally consistent (van Overveld et al., 2006) and has shown predictive validity for experiencing disgust in disgust-eliciting experimental tasks across all relevant disgust domains (van Overveld et al., 2010). In previous studies the scale was shown to be reliable, with the DPSS-R and its subscales' internal consistency all above Cronbach's $\alpha$ of .78 (van Overveld et al., 2006; Fergus and Valentiner, 2009). In our sample, the Cronbach's $\alpha$ for disgust sensitivity was .72 and .75 for disgust propensity.

**Emotional subjective ratings**

Participants were given two sheets with Visual Analogue Scales (VASs): to measure the impression of the task (step 1) and another for after the task was completed (step 4). The VAS was intended to rate their evaluation of their current mood e.g., how disgusted are you feeling at this moment? The participants had to mark with a pen on a VAS that ranged from zero (not at all) to 10 (very). As a measure of the affect induced by the film clips (manipulation check), we also included a VAS to measure their feeling of sexual arousal. Additionally, the participants had to indicate using a binary score whether they indeed completed or decided not to do the task, with a zero (not done) or 1 (completed).

**Procedure**

The experiment took place in a quiet room, divided from the experimenter's room by a one-way screen.Participants were seated in front of a large projection screen ($1.5 \times 1.5$ m) and had a table in front of them to conduct the tasks on. The experimenter was on the other side of the room (behind a one-way divider) from where it was possible to observe the participant whilst giving instructions over a microphone (steps 1 - 4). Participants were warned before starting the experiment that they might be asked to view erotic images and that they would be asked to touch or do things that they could find unpleasant.

They were told that they could decide not to conduct step 3 (the actual doing/approaching part) of the task and then to report whether they did conduct or if they declined. In the case of no task completion (i.e., not completing step 3), the participant was asked to imagine as if they actually did conduct the task requested

and rate the emotions elicited. No participant opted to withdraw from the study once the explanation was given.

The design of the study entailed that participants had to watch a 5 minute film to set the mood. Next, the screen was set to freeze, and the experimenter brought in one stimulus. After two tasks (i.e., one stimulus at a time), the film continued for 2 minutes before the screen was set to freeze and the 2 subsequent tasks/stimuli were presented and so on, until they had completed the full set of 16 behavioural tasks. The 8 steps (4 steps for each stimulus) of the behavioural task had to be completed whilst the film was stopped and screen frozen. With each task, participants were handed a two loose-leaf rating sheet (one for rating at the impression of the task - step 1 and another for the rating after the task was completed - step 4) for each of the 16 tasks. The 16 tasks were counterbalanced: specifically we had 4 different orders for counter-balance. Each rating sheet was given a number that varied by the condition and the group/order they had been randomly allocated to. After the behavioural measures were completed participants were given a set of questionnaires to complete in private. Finally, participants were fully debriefed about the purpose of the experiment, the stimuli and the nature of the behavioural tasks. Appendix 8.A Table 8.4 illustrates the behavioural tasks as perceived by participants, and what the stimulus entailed in reality.

Refreshments were given to participants together with a modest monetary gift (i.e., 10 Euros). The full duration of the experiment took 2 hours per participant. This study was approved by the University of Groningen Psychology Ethical Committee, ECP [ECP-code 10336-NE]. Furthermore, written informed consent was obtained from all participants involved in the study.

## 8.3 Results

*Manipulation check of induced sexual arousal as the mood of interest.* As a manipulation check of affect induced per group, we conducted a one-way analysis of variance (ANOVA) to assess the impact of sexual arousal as the induced mood of interest, on group (sexual arousal, positive arousal and neutral/baseline) at the impression of the task presented (Step 1). That is to assess whether the mood induced was effective throughout the 16 tasks that had to be completed (step 1 of each task). There was a significant difference between the 3 groups on sexual arousal ratings $[F(2, 87) = 12.71,\ p < .01)]$. Attesting to the validity of mood induction, post hoc comparisons using LSD tests indicated that the sexual arousal group expressed significantly higher scores on sexual arousal ($\text{M} = 1.4$, $\text{SD} = 1.0$), compared to the neutral group ($\text{M} = .53$, $\text{SD} = .82$, $p < .01$) and the positive arousal group ($\text{M} = .40$,

Table 8.2: Perceived level of elicited disgust as a function of group, stimulus type and time of measurement (before vs. after task).

| | Sex-related stimuli | | Non sex-related stimuli | |
|---|---|---|---|---|
| Group | before task | after task | before task | after task |
| Neutral | 6.9 (1.4) | 6.8 (1.8) | 6.6 (1.3) | 7.1 (1.5) |
| Sexual arousal | 5.4 (1.9) | 5.7 (1.8) | 5.6 (1.9) | 6.1 (1.5) |
| Positive arousal | 6.6 (1.8) | 6.8 (2.1) | 5.8 (2.1) | 6.7 (2.9) |

M(SD) M, means and (SD) standard deviations of the elicited disgust measured on a VAS per group.

SD $= .59,\ p < .01$).

*Propensity and sensitivity disgust traits as measured by the DPSS-R*. To verify the comparability of the three groups with regard to trait disgust sensitivity (DPSS-Sensitivity) or/and trait disgust propensity (DPSS-Propensity), we conducted a between group ANOVA on these variables. Supporting an equal distribution of scores on these disgust personality traits across groups, there were no significant differences between the 3 groups on trait disgust sensitivity $[F(2, 87) = 1.79,\ p = .2,\ \eta^2 = .03]$ or trait disgust propensity $[F(2, 87) = .95,\ p > .4,\ \eta^2 = .02]$. The means on the DPSS-Sensitivity were $9.2,\ 8.9$, and $10.8$; whereas on the DPSS-Propensity the means were $16.6,\ 16.3$, and $15.4$, for the sexual arousal, the positive arousal and the neutral group, respectively.

*The influence of sexual arousal on elicited feelings of disgust with disgusting sex versus non sex-related stimuli*. A mixed ANOVA, with 3 group (sexual arousal, positive arousal and neutral) as between-subject factor $\times$ 2 type (sex related vs. non sex-related disgusting task) as within-subject factor, was conducted to assess the impact of the mood induction on the perception of disgust on sex and non sex-related disgusting tasks. There was a main effect of group $[F(2, 87) = 4.52,\ p < .01,\ \eta^2 = .09]$ and a main effect of stimulus type $[F(1, 87) = 4.98,\ p < .05, \eta^2 = .05]$. Yet, these main effects were qualified by a significant interaction of stimulus type $\times$ group $[F(2, 87) = 4.63,\ p < .01,\ \eta^2 = .09]$.

To further examine this interaction term, we conducted two one-way ANOVA's comparing the three groups on disgust ratings for both sex-related disgusting tasks and non sex-related disgusting tasks. The first ANOVA with ratings for the sex-related stimuli showed significant difference between groups $[F(2, 87) = 6.35,\ p < .01]$. Thus we conducted post hoc comparisons using LSD tests which indicated that the participants in the sexual arousal group rated the sex related stimuli significantly less disgusting than the positive arousal group (M - diff $= -1.22$, SD $= .44,\ p < .01$) and also less disgusting than the neutral group (M - diff $= -1.47$, SD

Table 8.3: Impact of sexual arousal on elicited feelings of disgust per disgust subtypes

| | Disgust subtypes | | | |
|---|---|---|---|---|
| Group | Core | Moral | Animal-reminder | Contamination |
| Neutral | 7.4 (1.9) | 5.2 (1.7) | 7.7 (1.5) | 6.2 (1.6) |
| Sexual arousal | 6.0 (2.3) | 4.4 (1.7) | 6.4 (2.1) | 5.2 (2.2) |
| Positive arousal | 6.6 (2.3) | 5.2 (1.8) | 6.7 (2.3) | 5.9 (2.2) |
| Total score | 6.7 (2.2) | 4.9 (1.8) | 6.9 (2.0) | 5.8 (2.1) |

M(SD) M, means and (SD) standard deviations of elicited disgust per subtype as a function of group as measured on a VAS. Total score is the mean of the 3 groups per each disgust subtype.

$= .44,\ p < .01$). There was no meaningful difference between the positive arousal and the neutral group ($p = .58$). In the second ANOVA with the non sex-related stimuli, the global pattern was very similar although the group difference did not reach the conventional level of statistical significance [$F(2, 87) = 2.86,\ p = .06$]. Yet, paired comparisons using LSD tests indicated that the participants in the sexual arousal group rated the non sex stimuli as less disgusting than the neutral control group (M - diff $= -1.06$, SD $= .46,\ p < .05$). The difference between sexual arousal and positive arousal group did not reach significance ($p = .57$) and neither did the difference between the positive arousal and the neutral control group ($p = .08$) (Table 8.2). Appendix 8.A Table 8.4 illustrates the means of the subjective disgust ratings for each of the 16 behavioural tasks per group, and shows that the pattern of findings was highly consistent across all tasks.

*The influence of sexual arousal on elicited feelings of disgust from differential disgust subtypes* A mixed ANOVA, with 3 group (sexual arousal, positive arousal and neutral) as between-subject factor $\times$ 4 type (core, animal-reminder, contamination and moral disgust) as within-subject factor, was conducted to assess the impact of mood induction on the feelings of disgust elicited from the four different disgust subtypes. There was a significant effect of group [$F(2, 87) = 3.34,\ p < .05,\ \eta^2 = .07$] and a main effect of disgust type [$F(3, 261) = 49.69,\ p < .01,\ \eta^2 = .36$]. However, there was no significant interaction of type $\times$ group [$F(6, 261) = 1.0,\ p = 42,\ \eta^2 = .02$] hence, this effect of group was similar for all of the disgust subtypes. The pattern of the means for the 4 subtypes indicated that animal-reminder disgust elicited the highest disgust ratings, followed by core, contamination and moral disgust stimuli (Table 8.3).

*The impact of sexual arousal on actual approach behaviour and task performance*. Here, we conducted a repeated measure ANOVA with 3 group (sexual arousal vs. positive arousal vs. neutral) $\times$ 2 type (sex-related vs. non sex related disgusting tasks) on

percentage of task completed. There was no significant interaction between type $\times$ group, [Wilk's $\lambda = .98,\ F(2, 87) = .79,\ p = .46, \lambda = .02$]. There was neither a main effect of task type [Wilk's $\lambda = .97,\ F(2, 87) = 2.10,\ p = .15,\ \eta^2 = .02$]. However, there was a substantial main effect of group $[F(2, 87) = 7.71,\ p < .01, \eta^2 = .15]$. In line with predictions, paired comparisons using LSD tests revealed that the sexual arousal group conducted significantly more tasks than the neutral group (M - diff $= 16.76$, SD $= 5.76,\ p < .01$) and the positive arousal group (M - diff $= 21.53$, SD $= 5.76,\ p < .01$). The positive arousal group did not differ from the neutral group (M - diff $= -4.77$, SD $= 5.76,\ p > .05$). In line with our hypothesis both for the sex-related disgusting tasks and for the non sex-related tasks, the sexual arousal group conducted the highest percentage of tasks compared to the other two groups. For the sex related tasks the means were 89.33%, 65.33%, and 74.01% for the sexual arousal, positive arousal and neutral group, respectively. Similarly, for the non sex-related tasks the means of task performed were 84.95%, 65.90%, and 66.77% for the sexual arousal, positive arousal and neutral group respectively.

*Sexual arousal modulates the reduction in disgust following task performance.* To test whether induced sexual arousal additionally modulates the reduction in feelings of disgust following the actual task performance, we conducted a 3 group (sexual arousal, positive arousal, neutral) $\times$ 2 type (sex related vs. non sex-related tasks) $\times$ 2 time (pre task performance, post task performance) mixed ANOVA on elicited disgust. A main effect of time was noted $[F(1, 87) = 10.6,\ p < .01,\ \eta^2 = .11]$ indicating that overall there was an increase in elicited disgust from pre to post task performance. However there was no time $\times$ group interaction $[F(1, 87) = .71,\ p = .49,\ \eta^2 = .02]$. Therefore, this effect was found to be similar for all of the three groups, with no evidence to suggest that sexual arousal generally lessens feelings of disgust following task performance. Additionally, the effect of time varied across both task types $[F(1, 87) = 7.35,\ p < .01,\ \eta^2 = .08]$. This indicated that overall the increase of disgust from pre to post task performance was strongest for the non sex disgusting stimuli $[t(89) = 3.81,\ p < .001,\ \eta^2 = .02]$. None of the other main and interaction effects, including the 3-way interaction between group, stimulus type and time reached significance. This pattern of results did not support the initial view, namely, that the reduction in disgust would be strongest for the sexual arousal group.

*A test of mediation.* To test if the impact of the experimental manipulation ($[A]$ sexual arousal group, versus both neutral and positive arousal group) on approach behaviour during the actual behavioural task ($[C]$ Behavioural task), is mediated by changes in subjective disgust ($[B]$ VAS-disgust) we conducted 3 linear regression

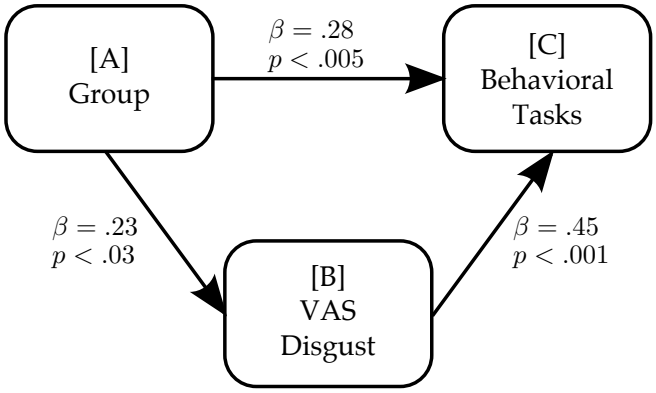



Figure 8.2: Testing mediation effects of self-reported disgust

analysis for assumption checking ($[A > C], [A > B], [B > C]$), then we conducted a multiple regression analysis with ($[A, B > C]$) to test the mediation effect of $[B]$. As illustrated in Figure 8.2 there was a trend for partial mediation with $[B]$ still making a unique significant contribution, $[\beta = .28\ (p < .005)]$ also when both $[A$ and $B]$ were included in the equation[1]. Thus the impact of induced sexual arousal on approach behaviour was not fully mediated by the influence of sexual arousal on subjective disgust. Hence, the change in approach behaviour and the change in subjective disgust seem largely independent outcomes of the induced sexual arousal.

*Influence manipulation as a function of trait disgust*. Finally we explored, whether the effect of the sexual arousal induction might have varied according to the level of self-reported disgust susceptibility (i.e., disgust propensity). We conducted two linear regressions, the first analysis to predict the subjective elicited disgust and the second analysis for the prediction of percentage of behavioural tasks completed. We included Group, and DPSS-Propensity disgust trait at first level and in the second level we included the interaction term (Group $\times$ Disgust trait). In line with expectations the first analysis showed that the main effect of DPSS-Propensity reached the conventional level of significance $[\beta = .40,\ (p = .02)]$. In the second step the DPSS-propensity retained significance whilst the interaction term (Group $\times$ Disgust trait) did not contribute significantly to the model $(p = .49)$. Thus in line with predictions, independent of the film manipulation, high trait disgust participants responded generally with more disgust during the presented tasks. Similarly, we

[1]The trend for partial mediation with (B) still making a unique significant contribution is reported as ($\beta = .28,\ p < .005$) in text of the published paper and here in the figure. However, this was not accurately reported in the figure of the published paper.

conducted the second regression analysis to test the influence of trait disgust (i.e., DPSS-propensity) on approach behaviour. At the first step the DPSS-Propensity reached the conventional level of significance [$\beta = -4.9,\ p = .04$] whilst in the second step the interaction term Group $\times$ Disgust trait did not approach significance ($p = .11$). This finding indicates that high disgust trait participants indeed completed less behavioural tasks.

## 8.4 Discussion

The core findings can be summarized as follows: first, the sexual arousal group rated the sex related disgusting stimuli as significantly less disgusting when compared both to the neutral group and to the positive arousal group. A similar (non-significant) trend was evident for the non sex-related stimuli. Second, for both the sex and non sex-related disgusting tasks, the sexual arousal group conducted the highest percentage of tasks, indicating that sexual arousal indeed accentuates the actual approach tendency towards disgusting stimuli.

In line with predictions, when specifically considering the sexual arousal group, this group showed reduced elicited disgust towards the sex-related (and to a certain extent also for the non sex-related) disgusting stimuli. This effect of sexual arousal on disgust cannot be attributed solely to positive arousal, given that the effects, especially at the behavioural level, were restricted to the sexual arousal condition. These results are congruent with the findings of a previous study conducted with male participants (Stevenson et al., 2011). Although in the previous study the effects were restricted to disgust stimuli that referred directly to sex, in the present study the effect of induced sexual arousal was also evident for stimuli that do not directly refer to sex (Appendix 8.C Table 8.6). This apparent difference between studies could perhaps be attributed to the intensity of the experimental manipulation as Stevenson and colleagues used slides instead of a film clip to elicit sexual arousal (Stevenson et al., 2011).

The current study presents evidence that, similar to men, sexual arousal in women attenuates the elicited disgust of particular disgusting stimuli (Stevenson et al., 2011). Importantly, however, our findings go further than merely replicating the self-report data of the aforementioned studies through demonstrating that sexual arousal also affects participants' behaviour and attenuates actual approach tendencies. This seems particularly relevant here, when one considers that the subjective self-reported disgust does not mediate the impact of the experimental condition on the willingness to approach and conduct the tasks. This suggests that sexual arousal seems to have a largely independent influence on the experience of disgust

and on people's tendency to avoid disgust-relevant stimuli.

Although, participants in the sexual arousal group rated the non sex-relevant stimuli as less disgusting than the neutral control group, such difference was absent between the sexual arousal- and the positive arousal group. This could indicate that the impact of the sex film on subjective disgust is mainly driven by the generally arousing properties of the same sex film. Thus, the impact of the sex film on the subjective appreciation of sex-relevant disgust elicitors might be driven by its specific power to elicit sexual arousal, whereas its effect on the appreciation of non sex disgust elicitors might be more driven by its generally (sex-independent) arousing properties. The impact of the sex film on participants' actual approach of sex-relevant and sex-irrelevant disgust elicitors seems specifically driven by its power to elicit sexual arousal, as the sex-irrelevant arousing films did not affect participants' avoidance tendencies (neither for the non sex nor for the sex-relevant disgusting tasks). Together, the present pattern of findings not only shows that feelings and avoidance of disgust represent (partly) independent phenomena, it also suggests that they are differentially influenced by sexual arousal. Perhaps most important for the present context, the findings indicate that both the impact of heightened sexual arousal on subjective disgust and also on disgust-induced avoidance will act in a way to facilitate the engagement in pleasurable sex and can be problematic if one of the two is not influenced or modified by sexual arousal.

From a *clinical standpoint* these findings can indicate that lack of sexual arousal (perhaps due to inappropriate stimulation) may interfere with functional sex, as it may prevent the reduction of disgust and disgust related avoidance tendencies. Consequently, if sexual arousal is low (for a variety of possible reasons), the disgusting properties of specific stimuli, which are relevant for the engagement in pleasurable sex, as well as the hesitation to approach these stimuli are not attenuated. As a result, this could lead to problems with sexual engagement, and lack of vaginal lubrication, which in turn could increase friction and cause problems such as pain with intercourse. It is thus possible that in extreme cases the woman might acquire negative associations with sex and might start to avoid sexual intercourse altogether.

Relevant to this, our previous studies with women suffering from vaginismus (Genito-pelvic pain disorder/penetration disorder) have shown that they experience disgust responses towards erotic stimulation at the subjective as well as at a more automatic level (Borg et al., 2010; de Jong et al., 2009). Moreover, the fact that sex related stimuli appeared to elicit disgust rather than arousal in women suffering from vaginismus might further worsen the problem. This is relevant here, since a typical response to disgust is avoidance behaviour in order to create distance from the disgusting stimuli. Thus, it is highly possible that these sexual problems can be directly or indirectly related to low sexual arousal, which as a consequence gives

more room for the elicitation of disgust, resulting in a downward spiral and continued maintenance of their difficulties and sexual dysfunction.

Sexual-arousal-induced reduction of people's avoidance of disgust-relevant stimuli was not restricted to sexual stimuli but seems to reflect a more general phenomenon that also applies to disgusting stimuli in general. The result that sexual arousal was quite similar across various categories further underlines the conclusion that the influence of sexual arousal reflects a more general phenomenon (not restricted to sex-related disgust stimuli or any other subtype of disgust).

The absence of a decrease of (sexual) disgust after actual exposure to the disgusting tasks (following sexual arousal induction) could indicate that there was no additional impact on the rate of habituation. However, it should be noted that due to the weakening influence of sexual arousal on the initial feelings of disgust at the starting point, there was already a difference between conditions, leaving less room for further reduction in the sexual arousal group.

### 8.4.1 Limitations and further studies

*Some limitations should be mentioned:* to verify the efficacy of our experimental manipulation we have entirely relied on subjective ratings of participants' sexual arousal; it would be interesting to see whether this film clip is also successful in eliciting physiological arousal in addition to subjective sexual arousal. A physiological measure (e.g., vaginal photoplethysmograph) would be appropriate because strictly speaking, in the current design it cannot be ruled out that test- and experimenter demands might have played a role in participants' ratings of the manipulation check question about their sexual arousal. However, this may be considered unlikely, as the fact that, at the behavioural level specifically the sex arousal group showed less avoidance behaviour would be inconsistent with a demand explanation.

Furthermore, although this study refers to sex-related disgusting tasks and to non sex-related disgusting tasks, we cannot be entirely sure, if what we denote as sex-related actually differed from the non sex-related disgusting stimuli in the perception of the current participants in terms of sexual relevance (vs. non sex-relevant). Yet, by and large the ratings of an independent group of participants confirmed the validity of the present division in a sex-relevant versus a non sex-relevant category. Although it should still be acknowledged that the task referring to a shirt worn by a paedophile clearly diverged in terms of reported sex relevance from the other stimuli (that were a priori assigned to the non sex category)(see Appendix 8.C, Table 8.6). Therefore, we re-ran the analyses without this particular task. Removing this task had no meaningful impact on the outcome of the analyses. This renders it unlikely that the absence of a differential impact of sexual arousal on sex-relevant

versus non sex-relevant stimuli could be attributed to flaws in the categorisation of our tasks, thereby sustaining the validity of the current pattern of findings.

Automatic avoidance tendencies might be critically involved in the affective, behavioural and physiological processes relevant for sexual engagement. Thus, it would be important to further investigate whether the findings of this study are also evident for the more automatic, reflexive physiological disgust response that can be assessed using an electromyography (EMG) of the levator labii (Borg et al., 2010) or the pelvic floor muscles (van der Velde et al., 2001) as relatively uncontrollable defensive responses

In addition, it would be interesting to investigate the influence of sexual arousal on the disgust eliciting properties of particular stimuli in different groups. Perhaps in women with sexual dysfunction such as dyspareunia or vaginismus, arousal does not impact on disgust which might help explain the occurrence and persistence of sexual pain or vaginistic symptoms.

### 8.4.2 Conclusions

The current findings enhance our understanding of how sexual arousal interplays with disgust and disgust eliciting properties of both sex and non sex-related disgusting stimuli in women. Specifically, these findings further the existing literature-base by showing that this relationship goes beyond subjective reports to reach the behavioural level through facilitating the actual approach to the same stimuli. In other words, this study might help develop our insight into the quandary as to why people still manage to engage in pleasurable sex despite the disgusting nature of many stimuli that are implicated in sexual behaviours. The present array of findings not only suggests that high sexual arousal may facilitate common sexual behaviours but also suggests that low sexual arousal might be a key feature in the maintenance of particular sexual problems or dysfunctions.

# Appendix 8.A. Description of the behavioural tasks

Table 8.4: Behavioural tasks as perceived by participants

| | As Perceived | In Reality |
|---|---|---|
| 1 | take a sip of the juice with a large insect in the plastic cup | insect was made of plastic |
| 2 | remove the used toilet paper from the jar and put it back in place | toilet paper was spoiled with sweet bread to give the impression of faeces |
| 3 | wipe your hands with the used tissue | tissue was touched with yellow-brownish ink |
| 4 | take a bite from the biscuit, which is lying next to a living worm | the worm was indeed living and was kept for the duration of the experiments in a large container with blocks of soil in it and it was taken back to the same field when experiments were completed |
| 5 | lubricate the vibrator with your hands | the vibrator was clean |
| 6 | insert the needle into the heart of the voodoo doll representing the person you hate | n/a |
| 7 | this shirt belongs to a paedophile that was used during rape - take the shirt out of the bag and hug it | the shirt was new and clean |
| 8 | read the story and say aloud: "It was so horny to have him (the dog) inside me" | n/a |
| 9 | touch the (unattached) wet human hair | the hair belonged to one of the researchers and it was wet with a neutral lubricant |
| 10 | hold the bone for 5 seconds | the bone was a 'dog's chewing bone' lubricated with red ink |
| 11 | discard the used women tampon | the tampon was new soaked in red ink and water |
| 12 | stick a needle in the eye of a cow | the eye of the cow was real, and participants had to only touch it with the needle provided - a new eye ball was brought every day as frozen from the butcher and taken back at the end of the day for proper biohazard waste removal |
| 13 | hold a bandage that was used on a wound for 5 seconds | the bandage was new and spoiled with red and brownish ink |
| 14 | rub the used toothbrush back and forth on your cheek for five seconds | the toothbrush was new |
| 15 | place the used panties/knickers of a woman in a bag | the panties were unused and spoiled with drops of coconut milk |
| 16 | stick your finger in the bowl of used condoms and touch each one of them | the condoms were new and wet with penile lubricant |

These behavioural tasks were given randomized in a set of 2, each time following 2 minutes film clip. Each task was given in 4 steps (see Methods).

# Appendix 8.B. Subjective disgust per each behavioural task

Table 8.5: Subjective disgust per each behavioural task

| Group | Sexual arousal | | Positive arousal | | Neutral | |
|---|---|---|---|---|---|---|
| Elicited emotion | Disgust | Sexual arousal | Disgust | Sexual arousal | Disgust | Sexual arousal |
| | M (SD) | M (SD) | M (SD) | M (SD) | M (SD) | M (SD) |
| Task 1 | 4.4(2.9) | 1.1(1.3) | 4.8(3.8) | 0.1(.2) | 6.3(3.4) | .3(.7) |
| Task 2 | 6.7(2.9) | 1.3(1.4) | 7.1(3.2) | .2(.5) | 7.7(2.4) | .4(1.1) |
| Task 3 | 6.2(2.6) | 1.7(1.9) | 7.2(2.8) | .2(.3) | 7.1(2.4) | .2(.6) |
| Task 4 | 6.5(3.0) | 1.1(1.5) | 7.3(2.7) | .1(.2) | 8.5(2.1) | .2(.5) |
| Task 5 | 2.4(1.6) | 3.1(1.9) | 3.7(2.7) | 1.8(2.3) | 3.5(2.7) | 1.5(1.5) |
| Task 6 | 2.6(2.4) | 1.5(1.6) | 2.7(2.6) | .1(.2) | 2.8(3.1) | .3(.9) |
| Task 7 | 5.4(3.2) | 1.1(1.2) | 5.7(3.3) | .2(.6) | 5.8(3.3) | .5(.9) |
| Task 8 | 7.0(3.0) | 1.2(1.5) | 8.5(2.3) | .5(.9) | 8.7(2.4) | .8(1.4) |
| Task 9 | 6.1(2.5) | 1.5(1.6) | 6.2(3.3) | .2(.3) | 6.6(2.6) | .3(.6) |
| Task 10 | 5.6(3.2) | 1.6(1.8) | 5.8(3.2) | .2(.4) | 7.4(2.5) | .2(.6) |
| Task 11 | 6.3(2.7) | 1.7(1.9) | 7.9(2.4) | .4(.8) | 8.2(1.8) | .4(1.0) |
| Task 12 | 7.6(2.3) | .7(.9) | 7.1(2.9) | .2(.4) | 8.6(1.6) | .2(.6) |
| Task 13 | 5.1(2.3) | 1.2(1.3) | 5.7(3.2) | .3(.7) | 6.2(2.7) | .2(.7) |
| Task 14 | 4.5(3.2) | 1.3(1.4) | 4.9(2.9) | .6(1.8) | 4.7(3.0) | .4(1.0) |
| Task 15 | 5.2(2.2) | 1.3(1.4) | 6.1(2.6) | .7(1.8) | 6.9(1.6) | .5(1.3) |
| Task 16 | 6.2(3.1) | 2.5(2.1) | 7.0(2.7) | 1.3(2.0) | 7.1(2.5) | 1.7(2.4) |

Means and (SD) standard deviations of the subjective disgust ratings for each behavioural task per group in order to show that the pattern of findings seem to be similar for all of the 16 behavioural tasks.

# Appendix 8.C. Sex relevance per task

Table 8.6: Sex-relevance per each behavioural task.

| | Sex Relevance M (SD) |
|---|---|
| Task1 | 7.7(13.2) |
| Task2 | 3.1(5.1) |
| Task3 | 8.5(12.8) |
| Task4 | 2.9(3.1) |
| Task5 | 83.9(9.4) |
| Task6 | 3.3(5.8) |
| Task7 | 41.3(18.6) |
| Task8 | 77.2(7.7) |
| Task9 | 15.0(17.1) |
| Task10 | 6.1(6.6) |
| Task11 | 46.4(19.9) |
| Task12 | 2.0(3.0) |
| Task13 | 5.1(2.3) |
| Task14 | 3.5(4.7) |
| Task15 | 54.6(23.9) |
| Task16 | 75.4(12.7) |

Means, and Standard Deviations(SD), of the subjective (post hoc) ratings for each of the 16 behavioural tasks. The sex relevance is the mean result from the VAS. Task number 5, 8, 11, 15 and 16 are the behavioural tasks considered sex-relevant.

# Chapter 9

# Summary and research avenues

## 9.1 Overview of main aims and objectives

This thesis started with a description of the female sexual pain disorders, with focus on existing theories about the factors involved in the generation and persistence of vaginismus. I presented a detailed description of the diagnostic criteria for vaginismus and dyspareunia, and discussed the boundaries between both types of female sexual pain disorder (see Section 1.1.2). This was followed by a description of the negative emotions underpinning sexual pain disorders or as they are now referred to as genito-pelvic pain/penetration disorder (GPPPD) (Binik et al., 2010), with attention to the emotion of disgust. Next, a comprehensive explanation of disgust has been provided (including clusters of elicitors, its state and trait components, and mentioned in which aspects the various disgust domains converge). Finally, I explored how all of the latter can be intertwined with particular sexual problems. This introduction led to the main research questions that were addressed in the empirical chapters (Chapter 2 to 8). In this part the main findings will be summarized, and after assimilating these findings in light of the hypotheses, the general limitations are discussed. Subsequently, focus is placed on what leads we can take for follow up research directions in this young research field that connects disgust, sex, and sexual dysfunctions. This chapter will be closed with outlining the main implications of our research findings.

## 9.2 Assimilation of the empirical chapters

To summarize: research in this thesis has shown that women with vaginismus indeed are characterized by stronger pain catastrophizing cognitions than both women with no penetration disorders and women with dyspareunia. Moreover, (only) when compared to women free of sexual pain, women with vaginismus scored higher on harm avoidance (see Chapter 2). This was followed by Chapter 3, where we described data which showed that specifically the vaginismus group showed relatively low scores on liberal values combined with comparatively

high scores on conservative values when compared to women with no sexual pain. In Chapter 4, it was demonstrated, that women with penetration disorders had stronger automatic penetration-disgust associations than women without sexual problems. In addition, in this chapter it was pointed out that specifically the vaginismus group responded with an increase of facial levator activity in response to the erotic stimulation. Next, I discussed the brain processing of disgust- and disorder specific stimuli (i.e., penetration stimuli) in asymptomatic women.

In Chapter 5, it was suggested that animal-reminder (AR) and core disgust can indeed be distinguished at the brain level and that disgust traits (propensity, sensitivity) moderate the disgust response; followed by Chapter 6, where it came out that in a group of asymptomatic women, many brain areas responded to penetration specific stimuli in the same way they responded to highly aversive disgust stimuli. Then, in Chapter 7 we subsequently reported the findings that this difference distinguishing women with penetration disorders was absent at the neural level, but across all women there was more overlap between penetration- and AR- induced brain activation. Finally, in Chapter 8, it was described that when women are sexually aroused, they rate the sex relevant disgusting stimuli as less disgusting, when compared both to the neutral and to the positive arousal group. In the latter chapter it was also noted that, for both the sex and the non-sex relevant disgusting (behavioural) tasks, the sexual arousal group conducted the highest percentage of tasks. To facilitate the integration of these findings, the results of the seven empirical studies will be discussed in connection to the heuristic model displayed in Figure 9.1. The DAMP-model visualizes the alleged interrelationships between the four main components discussed in this thesis - namely, disgust, pain, morality, and sexual arousal.

When a person is exposed to sexual stimuli, this will generally elicit sexual arousal, which in turn will facilitate approach tendencies and inhibit the experience of negative emotions such as disgust (Borg and de Jong, 2012). Moreover, sexual arousal will by physiological changes such as engorged sexual tissues of the vulva, clitoris, and vaginal walls, as well as vaginal lubrication, facilitate the actual penile-vaginal penetration. These physiological changes in preparation for coitus, could in turn, reduce friction, and prevent pain. However, a sexual stimulus can also elicit (vulvar) pain, which will probably hinder sexual arousal and the readiness to have sex (Reissing et al., 2004; Weijmar Schultz et al., 2005). The experience of painful sex may promote the generation of pain expectancies and pain related catastrophical beliefs, which will logically motivate avoidance (Lykins et al., 2011; Payne et al., 2005). In addition, sex might also give rise to disgust (Borg et al., 2010; Borg and de Jong, 2012). Disgust will motivate avoidance away from the sexual stimuli and could perhaps inhibit sexual arousal (de Jong and Muris, 2002). Moreover, as it is il-

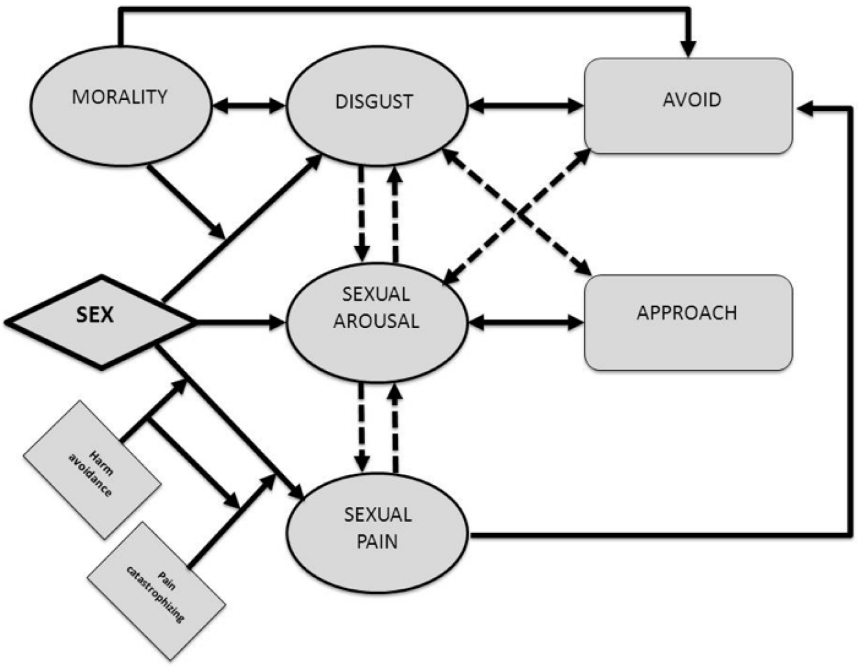



Figure 9.1: DAMP-Visualization diagram. In this model, the black-solid arrows represent an excitation (+) and the black-intermitted arrows represent inhibition (−). This model and its various components are discussed throughout the discussion.

lustrated in the DAMP-model, the presence of restrictive moral standards (that also apply to one's sexual repertoire) may lower the threshold for experiencing disgust (Ward and Ogden, 1994; Yasan and Akdeniz, 2009). This is particularly so for sex cues or stimuli easily perceived as transgressions. Transgressing socio-moral values is a powerful cue for the elicitation of disgust, which can lead to avoidance. Besides, the actual experience of disgust may further enhance the strength of people's values. That is, the disgust triggered by transgressions may amplify the already existing restrictive sexual attitudes (Schnall et al., 2008).

Throughout this discussion, I will relate the findings of each empirical chapter to the relevant parts of the proposed heuristic DAMP-model in an attempt to highlight what has been tested, and what remains unanswered regarding the alleged interrelationships that are displayed in the model.

## 9.3 Vulnerability and maintaining factors in female sexual pain disorders

In this section, I will integrate the findings of Chapter 2 that explores the potential involvement of pain catastrophizing cognitions (PC) and traits of harm avoidance (HA), together with the findings from Chapter 3 about the level of adherence to moral standards and specific sex beliefs as potential vulnerability and/or maintaining factors in vaginismus. This will be followed by the disgust related studies.

### 9.3.1 Pain

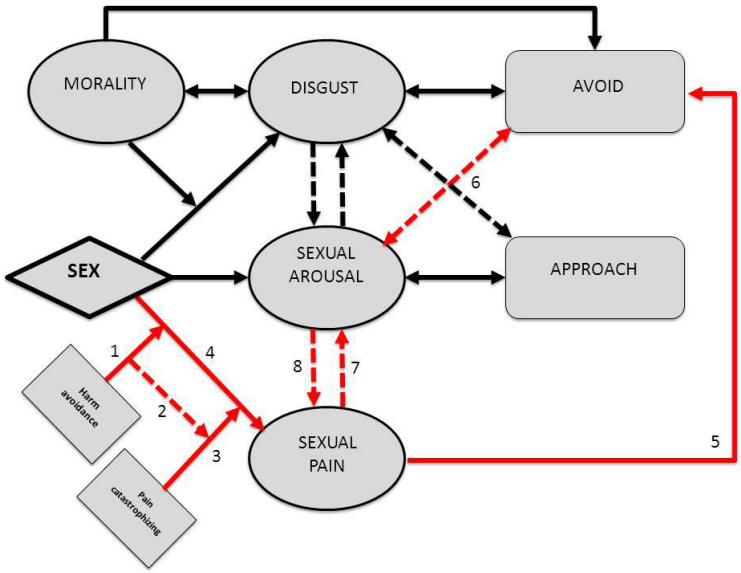



Figure 9.2: The red lines indicate the pain pathway in DAMP. Sexual cues can also trigger pain or the anticipation of it (4). Pain subsequently leads to avoidance in order to prevent this noxious event (5).

In a recent book about female sexual pain disorders, Elke Reissing proposed that the fear-avoidance model previously applied to chronic musculoskeletal pain, could also be applied to sexual pain disorders such as vaginismus, as similar affective and cognitive processes seem to be involved in the perception and maintenance of sexual pain (Reissing, 2009). She referred to this model as the vicious cycle of vaginismus (see Figure 9.3).

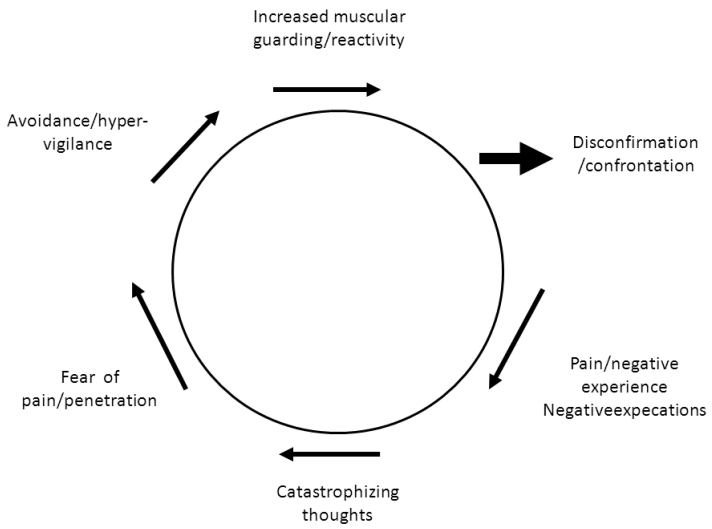



Figure 9.3: The vicious cycle of vaginismus by Elke Reissing (Reissing, 2009)

In the same vein, previous studies in the context of musculoskeletal pain have shown that habitual PC and fear-avoidance beliefs may contribute to the development and/or maintenance of pain symptoms (Reissing, 2009; Dewitte et al., 2011; Brauer et al., 2007; Desrochers et al., 2010). Thus, the habitual tendency to interpret pain signals in a catastrophic manner may be involved in the transition from acute to chronic pain symptoms (Susan et al., 2002; Edwards et al., 2009). In line with this, the fear-avoidance model of chronic pain indicates that catastrophic appraisal of experienced pain may promote hyper-vigilance and avoidance behaviour (Leeuw et al., 2007; Payne et al., 2005). Hyper-vigilance has been long attributed to cognitive misinterpretation and perceptual amplification of bodily sensations (Watson and Pennebaker, 1989; Barsky and Klerman, 1983). Similarly, in women with vaginismus, sexual pain or the anticipation of pain may give rise to catastrophic ideation (Reissing, 2009). Evidence suggests that this same anticipation of catastrophic consequences may well contribute to hyper-vigilance towards painful sexual stimuli, which further contributes to a negative appraisal of sexual cues, and avoidance (Lykins et al., 2011; Payne et al., 2005). Additionally, attempts of penetration that are met with increased muscle tone may add to the negative cognitions. Relevant to the vicious cycle of vaginismus is the evidence that women with sexual pain show heightened vigilance for coital pain and selective attention toward pain

stimuli (Payne et al., 2005).

One would expect that women who show a habitual tendency to make such catastrophic interpretations of pain, are also likely to apply a similar strategy to situational pain during (attempts of) penetration. Accordingly, if indeed dysfunctional pain cognitions play an important role in the aetiology and maintenance of sexual pain disorders, women with high PC cognitions would be especially vulnerable to these symptoms. Thus, as a group, women with vaginismus would have higher levels of PC cognitions compared to women with no sexual pain.

Consistent with this line of reasoning, in the present study women with vaginismus indeed showed higher PC scores, when compared to both women with no sexual pain and to women with dyspareunia (Borg et al., 2011). It should be acknowledged however, that in apparent contrast to the present findings previous research largely failed to provide evidence for enhanced PC in vaginismus (Reissing et al., 2004; Pukall et al., 2002). This apparent discrepancy in findings might well be due to differences in selection criteria. In the present study, a very strict categorization was used, in that only women with lifelong vaginismus and no underlying provoked vestibulynia (PVD) were assigned to the vaginismus group (see Section 1.1.2, for a detailed description of the diagnostic procedure). In lifelong vaginismus, trait PC may prevent successful penetration, whereas in acquired vaginismus, penetration was possible and only after a specific event it became impossible. Thus in secondary vaginismus specific experiences rather than pre-morbid traits may be most critical. Perhaps, then, differences in the diagnostic procedure and/or severity of the cases may help explain why there was neither a significant difference between the vaginismus and the healthy control group, nor between women assigned to the vaginismus and those assigned to the dyspareunia group in the aforementioned previous study (Reissing et al., 2004; Pukall et al., 2002).

In addition, the findings indicated that, compared to women free of sexual pain, women with vaginismus scored higher on HA (i.e., individuals' habitual sensitivity for signals of punishment). This is consistent with the view that catastrophic appraisal of anticipated pain, may promote hyper-vigilance to pain and avoidance behaviour (see Figure 9.2) (Borg et al., 2012). Additionally, the finding that these women were inclined towards higher scores on HA (compared to the dyspareunia group), is in line with evidence indicating that women with vaginismus display stronger defensive reactions during gynecological examinations than women with dyspareunia (Reissing et al., 2004). Anecdotal clinical observations suggest that this avoidance is relevant as partial fulfillment of the diagnosis of vaginismus, though this is a highly debated argument (van Lankveld et al., 2010).

To relate back to the proposed DAMP-model, both PC cognitions (1) and trait HA (3) could jointly contribute to strengthen the link between sexual cues and (antici-

pation of) pain (4) by eliciting further catastrophe avoidance type of behaviour (5). This avoidance might inhibit sexual arousal (6), which perhaps due to low physiological preparation increases pain (7). We anticipated that the relationship between vaginismus and PC would be especially pronounced in high HA individuals, this appeared however not to be the case. Although the combined presence of high PC and high HA was most predictive for the presence of vaginismus, the additional predictive validity of PC was especially pronounced for women with low instead of high HA (5). However, this probably reflects a ceiling effect. That is, once HA is high to a certain extent, it overshadows the importance of the other main effect (i.e., PC) and vice versa. These findings are consistent with the idea that women with both high PC as well as high HA might be especially at risk for developing and maintaining the vicious cycle of vaginismus.

The implicit assumption underlying the proposed moderating influence of the relationship between sex and pain was that high PC would give rise to high penetration specific PC, which in turn would strengthen the relationship between attempts of sexual penetration (sex in the DAMP-model) and (the anticipation of) pain. However, it should be acknowledged that we only measured general PC and did not include a measure of pain/harm cognitions related to concrete sexual activities or sexual context. It remains therefore to be tested whether the relationship between PC and vaginismus is indeed mediated by penetration specific PC (i.e., cognitions that are confined to specific pain during penetration).

In addition, it should be noted, that in the present research project we did not actually measure whether sexual stimuli (e.g., attempts of penetration) would give rise to pain. Thus although the finding that heightened PC is associated with the presence of sexual pain disorders is consistent with the alleged moderating influence of general PC, it remains to be tested whether high PC actually moderated the experience of pain, when exposed to particular sexual activities. Hence, these findings though consistent with the proposed DAMP-model, are not in itself supporting this particular way in which PC is integrated in it (see Figure 9.2). In this study it was only indirectly examined whether PC cognitions could be a risk factor (by testing whether it correlates with vaginismus) based on the starting point that PC cognitions would be important as a vulnerability factor for the development of this disorder.

Furthermore, the present findings are cross-sectional and therefore silent with regard to the direction of the relationship between vaginismus and PC. Thus, it remains to be tested whether enhanced PC cognition and/or HA indeed sets people at risk for developing the disorder or promote the persistence of sexual pain, or on the other hand can best be interpreted as a consequence of the symptoms associated with vaginismus. This can be tested in women with vaginismus, pre and post

treatment to investigate the direction of the relationship of these traits and sexual pain. Should these traits be indeed risk factors for vaginismus, instead of a consequence of the symptoms surrounding vaginismus, they will remain unchanged following successful treatment. Moreover, this study relied exclusively on questionnaires, which naturally can be influenced by self-presentational concerns (social desirability). Yet, since pain and pain related cognitions are intrinsically subjective there are no straightforward solutions to circumvent the potential drawback of self-reports.

### 9.3.2 Morality

Apart from the evidence discussed above, namely that PC is associated with vaginismus, a strong adherence to moral values might also be involved in sexual pain disorders. Evidence suggests that strict moral principles, perhaps triggered by conservative cultures (e.g., women forbidden to have any pleasurable self-touching), strict religious beliefs (e.g., sex before marriage is considered sinful) or lack of appropriate or inaccurate education (e.g., masturbation is linked to infertility and penetration is painful), has for long been associated with the psychopathology of vaginismus (Silverstein, 1989; Ward and Ogden, 1994; Reissing, 2009).

The moral pathway in DAMP. Strong adherence to moral standards may lower the threshold for experiencing disgust for sex stimuli/behaviours that are perceived as transgressions. Transgressing socio-moral values is a powerful cue for the elicitation of disgust (1), that can lead to either hesitation to approach (8), or complete avoidance (2, 3). The elicited disgust and thus avoidance can have negative effects on sexual arousal (6, 9). In addition, the actual experience of disgust further enhances the strength of people's values (1).

Following the colored pathway in the model, restricted sexual values may set people at risk for experiencing negative emotionality (e.g., disgust) during sexual behaviours. The latter could very well be a result of some sort of violation of their moral boundaries. In other words, having more restrictions around sex may increase the inclination of these women to frame sexual cues as wrongdoing. This may elicit feelings of guilt, shame but also disgust. Germane to this, evidence suggests that transgressing socio-moral values is a powerful cue for the elicitation of disgust (Chapman et al., 2009; Zhong and Liljenquist, 2006). The elicited disgust as a reaction to transgression (socio-moral disgust) is found to be highly similar to the disgust that a rotten piece of meat (core/pathogen disgust) would elicit. In this reciprocal relationship of morality and disgust, previous research has reported the interesting finding that the actual experience of disgust further enhances the strength of people's values (Schnall et al., 2008). In other words, the disgust triggered by

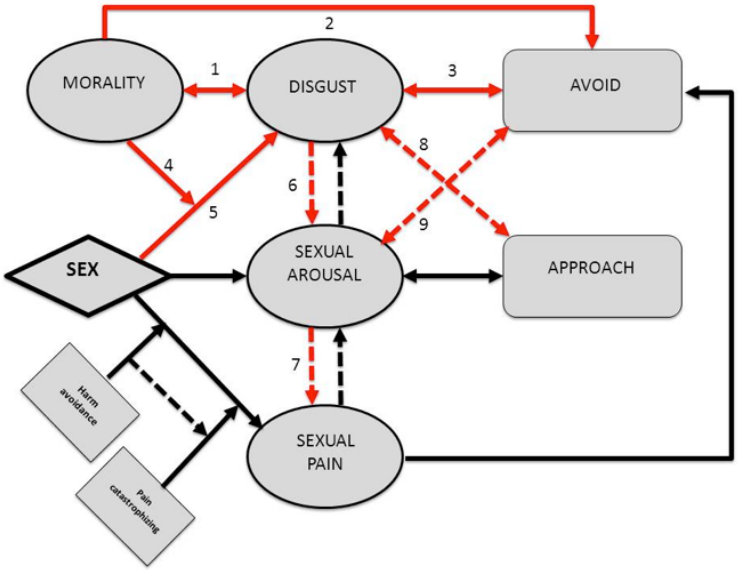



Figure 9.4: The red lines indicate the moral pathway in DAMP. The strong adherence to moral standards may lower the threshold for experiencing disgust for sex stimuli/behaviours that are perceived as transgressions. Transgressing socio-moral values is a powerful cue for the elicitation of disgust (1), that can lead to either hesitation to approach (8), or complete avoidance (2, 3). The elicited disgust and thus avoidance can have negative effects on sexual arousal (6, 9). In addition, the actual experience of disgust further enhances the strength of people's values (1).

transgressions, may amplify the already existing restrictive sexual attitudes (see Figure 9.4).

As a first step to examine the proposed role of restricted morality, in the study outlined in Chapter 3 it was tested whether women with vaginismus (or dyspareunia) hold stronger adherence to conservative moral values than asymptomatic women, and if this morality is also translated to beliefs surrounding sex. In line with expectations, these findings indicate that specifically the vaginismus group showed relatively low scores on liberal values combined with comparatively high scores on conservative values when compared to asymptomatic women (Borg et al., 2011). It is worth noting that the patterns in the women with dyspareunia lay between those with vaginismus and the asymptomatic women. This lack of significant differentiation between vaginismus vs. dyspareunia, and dyspareunia vs. healthy control, might be due to insufficient power to reliably detect small effects. To arrive at more final conclusions in this respect, it would be relevant to replicate this study using a

larger sample size.

Moreover, women with vaginismus were (sexually) more restricted in their willingness to participate in particular sex-related behaviours (e.g., watch a video clip in which your partner is masturbating, touch and carefully examine sex aids). In this study, the self-reported measure of the willingness to perform certain sex-related behaviours was independently associated with both the strength of conservative and liberal values. The position of the dyspareunia group, also shows relatively less willingness to participate in certain sex-related behaviours and more adherence to conservative/less adherence to liberal values, but not significantly different from neither the vaginismus group nor from the asymptomatic women.

As it is described in detail in Chapter 4, in the vaginismus group the enhanced disgust response towards sex stimuli (see Chapter 4) together with the reduced willingness to perform certain sex acts, can further enhance the impact of the (already present) value patterns and their implications (Schnall et al., 2008). Perhaps the stronger involvement of disgust in vaginismus compared to dyspareunia group may also help to explain why the difference of the clinical groups versus asymptomatic women (on general and sex-related moral standards), was especially pronounced for the vaginismus group. Similar to the results described in the previous section, the direction of the results cannot be confirmed given the cross-sectional nature of the study. In other words, it is also possible that women with vaginismus, for instance, because they never experienced sexual intercourse, feel less inclined to engage and to explore a broad(er) sexual repertoire. This goes in line with colloquial sayings such as 'the more you get - the more you want' or 'Use it or lose it'. While this may be an overstatement, it might help to understand that, because sex for these women is less pleasurable, they are also less motivated to engage in it.

On the other hand, the reduced willingness to perform these sexual acts can also be driven by avoidance in itself. Linked to the previous study for PC and HA, it remains to be tested whether strong morality is a trait, thus setting people at risk for symptoms of vaginismus, or if it should be considered a consequence of these symptoms.

To further disentangle these possibilities it might be useful to test the influence of sexual pleasure on the actual approach tendencies of specific sexual stimuli in women with vaginismus. Also, to specifically gain more insight into the alleged causal role of restrictive morals in the generation of symptoms surrounding vaginismus, it could be tested whether by challenging the strong adherence toward (sexual) morals and perhaps learning a more accepting attitude toward a broader range of sexual cues/behaviours, effects the symptoms associated with vaginismus. As illustrated in the heuristic DAMP-model, it also remains to be tested whether the existing strict morals mediate the relationship between sexual cues and the elicitation

of disgust (4). One way to test this relationship could be to compare women who are high in moral adherence with women who are low in moral adherence with regard to their strength of their disgust response when exposed to various types of sexual stimuli (generally reflecting transgressions). Another possible way to test the potential moderating role of the level of adherence to one's moral values for sexual cues and disgust, could be done by using a conditioning paradigm, namely, by pairing sex stimuli (i.e., cues of transgressions) to disgust (and neutral). If strict moral values do moderate this relationship, one would expect that this learning (sexual cues and disgust) would be quicker, stronger and more difficult to extinct for women with high devotion to their morals.

### 9.3.3 Disgust

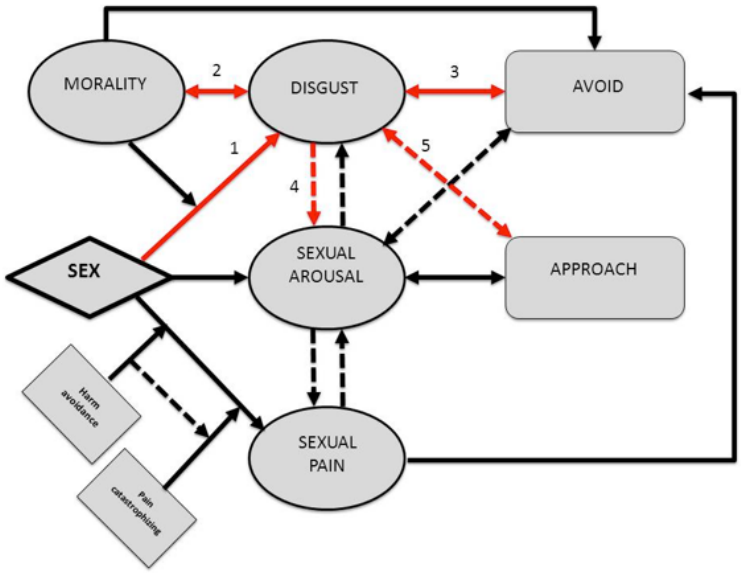



Figure 9.5: The red lines indicate the disgust pathway in DAMP. Sex can elicit disgust (1) which leads to avoidance in order to create distance away from the perceived contaminant (e.g., body products and specific body parts) (3). Elicited disgust might also hinder approach behaviour (5). Moreover, disgust can obstruct sexual arousal (4) and could further enhance the strength of people's already existing values/principals (2).

The third factor that is addressed in this thesis is disgust. In the last years, it has been proposed that disgust and fear of contamination may be involved in vaginismus (de Jong et al., 2009; Borg et al., 2010; de Jong et al., 2013; Cherner and Reissing,

2013). From an evolutionary stance, disgust has been associated with protection against contamination (Rozin and Fallon, 1987).

Perhaps more relevant for the theme of this thesis, is the evidence suggesting that various body parts and body products that are directly involved in sex, differ in their contamination sensitivity and disgust potency. For instance the mouth, vagina, and penis hold the highest subjective contamination sensitivity, alongside sweat, saliva and semen, which are considered amongst the strongest disgust elicitors (Rozin and Fallon, 1987). Moreover, disgust is highly associated with avoidant tendencies and defensive reflexes that may help to protect and to avoid (the anticipated) contamination (Yartz and Hawk, 2002). The latter could very well be reflected in the involuntary contraction of the pelvic floor muscles, which has been shown to be part of a general defense mechanism (van der Velde et al., 2001). Consequently, the prospect of mere physical contact with the vagina and/or the anticipation of penetration by the partner's penis may elicit flinching (Rozin et al., 1995; van der Velde et al., 2001).

Consistent with this, previous research has revealed that women with vaginismus score high on disgust propensity (de Jong et al., 2009). However, this earlier study, which relied exclusively on explicit self-report measures, provided no convincing evidence that these women also showed stronger disgust response towards sex-penetration stimuli (PEN). Thus, it remained to be tested whether indeed PEN elicit strong disgust responses in women with vaginismus.

**The automaticity of disgust responding in vaginismus**

Thus far, the results discussed in this chapter exclusively relied on explicit self-report measures. However, what social psychologists refer to as the dual process model, emphasizes the importance to differentiate between the deliberate, reflective attitudes (that can indeed be measured with self-reports) and the more automatic reflexive associations in memory (Gawronski and Bodenhausen, 2006). Both types of cognitions are believed to have different functional qualities. Explicit attitudes (that is when you take time to appraise or validate a stimulus) are assumed to reflect the outcome of the weighting of propositions and their corresponding 'truth' values, while automatic associations are assumed to follow from the direct activation of simple associations in memory, independent of their true value. Explicit attitudes tend to predict more deliberate behaviours, whereas automatic associations seem to play an important role in guiding spontaneous (reflexive) behaviours, the kind of behaviours that also seem critically involved in disgust induced defensive reflexes (Egloff and Schmukle, 2002; Huijding and de Jong, 2005).

Following such dual process perspective, it seemed reasonable to assume that especially the more automatically activated associations are most relevant in eliciting the characteristic defensive reactions in women with vaginismus. In this study, as described in Chapter 4, it was tested whether women with vaginismus show the tendency to (also) automatically associate PEN stimuli with 'disgust' instead of 'hot'. In line with expectations, women suffering from vaginismus indeed had stronger automatic PEN-disgust associations than women without sexual problems.

Considering that in clinical research vaginismus has recently been depicted as a penetration-specific phobia (Binik et al., 2010; ter Kuile et al., 2009), it seems reasonable, not only to anticipate PEN-disgust related associations, but also PEN-threat related associations (van der Velde et al., 2001). In line with this, the strength of the implicit association task effects (i.e., st-IAT, which is validated reaction time task) was very similar for PEN-threat and PEN-disgust associations within the two clinical groups (i.e., vaginismus and dyspareunia). In other words, also threat associations were present for these women. Yet, rather unexpectedly the strength of the PEN-threat associations was not different from that of women with no sexual pain. In this group the st-IAT effect was close to zero, which might indicate that they have an ambivalent attitude or at the very least not a strong PEN-safe (vs. threat) attitude. The absence of a difference in automatic threat associations in women with and without sexual pain disorders may be due to the explicit character of the applied (penis-vagina) PEN pictures which might refer to a more general threat value such as the risk of transmission of pathogens (perhaps because the vagina is an explicit body aperture) (Oaten et al., 2009; de Jong et al., 2013) or sexual violence. The threshold for eliciting these types of threatening associations might have been especially low because of the absence of sexual readiness or sexual arousal when participants processed these stimuli. Also the lab-context (penetration-incongruent) might have contributed to this rather negative appraisal (van der Velde et al., 2001). Thus it might still be that differences between groups with regard to their PEN-threat associations do arise in the proper context (and/or in the presence of sexual arousal).

It should be acknowledged that the enhanced automatic PEN-disgust associations were not restricted to women with vaginismus but were also evident in women suffering from dyspareunia (Borg et al., 2010). This pattern of findings may help explain the shared difficulties associated with vaginal penetration (either completely impossible in vaginismus or partially possible but with pain in dyspareunia). Also, this seems to be in line with clinical reviews that reinforce the difficulty to draw a clear line between dyspareunia and vaginismus. Given these difficulties to make a clear distinction between the two disorders, experts in the field seem to suggest that these conditions can be better taken on a continuum of sexual pain disorders and

name them genito-pelvic pain/penetration disorder (GPPPD) (Binik et al., 2010), rather than keeping them as two separate entities (Cherner and Reissing, 2013), which is the categorization for the new version of the DSM (DSM-5, 2013). Conceivably this distinction is dependent on the criteria used for diagnosis. For the purpose of the research included in this thesis, we only included women with primary/lifelong vaginismus, together with a group of women with dyspareunia as a clinical control group. Since vaginismus is given the main focus in this thesis, and due to the inconsistencies of the definitions used for this disorder, it was considered highly important to explicitly mention the foundations used for this group diagnosis (see Section 1.1.2).

As a further (more implicit) test of the role of disgust responsivity, we also recorded facial electromyography (EMG) of the levator labii muscle as a unique physiological marker of disgust (Vrana, 1993). To minimize self-presentational concerns (i.e., to exclude the risk of participants editing their attitudes in a way to fulfill what they might feel is expected from them), the stimuli used did not directly refer to the patient's partner. Underlining the potential importance of reflexive disgust response in vaginismus, here it was revealed that specifically the vaginismus group responded with an increase of levator activity in response to the erotic stimulation (Borg et al., 2010). Conceivably also here, the increased facial levator activity could indicate that women with vaginismus respond with a more intense general muscular response as a (disgust-induced) defensive response when compared to women with dyspareunia (van der Velde et al., 2001).

The vaginismus and the dyspareunia group differed also on their subjective ratings of the PEN related stimuli. Specifically women with vaginismus appraised the PEN stimuli as more disgusting compared to the other two groups and more threatening when compared to the women with no penetration disorders (but not from the dyspareunia group). Apparently, in the vaginismus group, in contrast to the dyspareunia group, the validation process does not give rise to a correction of the initial (PEN-disgust) association. Perhaps this may help explain why penetration is still possible in dyspareunia despite the pain, but not in vaginismus.

If a person is responding with disgust, it can be expected that sexual arousal might be hindered, which in turn could very well increase the probability that (attempts of) penetration inflicts more friction perhaps with insufficient lubrication and thus pain. Such mechanism might also help to explain how enhanced disgust responding might contribute to the development/persistence of sexual pain disorders. It should be acknowledged however, that the studies described in this thesis did not directly examine the impact of disgust on sexual arousal. Thus the alleged relationship between disgust and sexual arousal as displayed in Figure 9.6 remains to be tested. One way to test the alleged relationship between disgust and arousal

would be to test whether experimentally induced disgust indeed would hinder the generation of sexual arousal.

**Disgust-based mechanism at the brain level**

In an attempt to obtain more comprehensive insight in the role of disgust in the sexual pain disorders, we investigated the central processing of disgust and PEN stimuli in women with and without penetration disorders. The following three studies were designed to ultimately investigate whether women with vaginismus would indeed show a different pattern of activity to disorder-specific stimuli, that would more strongly resemble disgust responses (i.e., a stronger overlap in central processing maps in women with vaginismus) when compared to the other two groups (women with no sexual pain and dyspareunia, respectively) (Chapter 7, referred to as the third question/study). Yet, in order to be able to examine this hypothesis as explained in Chapter 1, we have included two studies (Chapter 5, and Chapter 6). The first study tapped on the neural correlates of disgust as a function of the disgust domain and as a function of trait disgust. Whereas, the second study examined how asymptomatic women respond to penile-vaginal PEN pictures.

**Central processing of disgust as a function of domain & trait**

In the last years, numerous neuroimaging studies have been published about the neural correlates of disgust. These studies consistently identified a set of brain areas associated with this emotion, which include the anterior insula, frontal operculum, amygdala, occipitotemporal cortex, orbitofrontal cortex, caudate-putamen and globus pallidus (Phan et al., 2002; Zald et al., 2002; Murphy et al., 2003). However, very few studies have taken disgust domains into account (Harrison et al., 2010). This negligence or lack of attention to disgust domains existed despite the fact that evidence in this field suggests that core and animal reminder (AR) disgust are two independent sub categories of disgust elicitors. It needs however to be mentioned here that the (current) dominant model of disgust classifications suggest that both core and AR are elicitors that inform us about the risk of pathogen transmission (i.e., pathogen disgust) but via two different pathways (oral vs. more body contact) (Tybur et al., 2013). Yet, numerous studies have shown that core and AR relate differently to the origin and maintenance of various psychopathologies (Olatunji et al., 2007, 2008; de Jong and Merckelbach, 1998).

Core disgust is represented by stimuli such as rotten food and feaces, and AR disgust elicitors are generally represented by stimuli such as surgical wounds and corpses. Both of these disgust domains can contribute to problems with sexual penetration. Feelings of disgust and fear of contamination can cause defensive reflexes

and avoidance behaviour in order to create distance away from contamination (core disgust). This is particularly so for the act of sexual penetration, as being an obvious threat for transmission of pathogens, particularly for women (de Jong et al., 2013). Thus, with evidence suggesting that involuntary contraction of the pelvic floor muscles is part of a general defense mechanism (van der Velde et al., 2001) it could be said that similar defensive contractions can be elicited by disgust-related appraisals (de Jong et al., 2013). Then the prospect of penetration may well elicit involuntary pelvic floor muscle activity as a disgust-induced defensive response. In addition, AR disgust may also play a role in penetration related problems. Previously it was argued that AR disgust mediated rejection of our animal nature to serve a defensive function by maintaining the hierarchical division between humans and animals (Haidt et al., 1994). Because sex is highly suggestive of the animalistic nature in humans, sex stimuli were then perceived as a possible elicitation of disgust. Yet, more recent conceptualizations of disgust have framed AR as just another pathway by which contamination can occur, and AR may thus just as core disgust elicit disease avoidance tendencies that might interfere with sex. Whereas core disgust seems more closely connected to oral ingestion mode of pathogen transmission, AR seems more strongly related to the transmission of pathogen via body products (e.g., saliva, semen) and the body apertures (e.g., vagina). Since both of these aspects are also intrinsically related to sexual intercourse, AR might even be more relevant for explaining symptoms of penetration disorders than (Tybur et al., 2013) core disgust. Thus AR might have even more to do with problems or psychopathologies related to sex and sexual penetration.

Earlier attempts that included similar elicitors to core and AR-like stimuli suggested a differential brain activity between the two (Harrison et al., 2010; Sarlo et al., 2005; Wright et al., 2004; Schienle et al., 2006). Therefore though not meticulously separating these two domains of disgust elicitors; still by using AR-like and core stimuli these previous studies (using AR like stimuli) do provide some further support that disgust carries subcategories that are fundamentally distinct. However, it should be noted that the stimuli in these studies may have been suboptimal, in that they had not distinguished AR and core disgust precisely. Neither were these domains distinguished meticulously from emotions that characteristically overlap and/or correlate with these subcategories of disgust (e.g., fear with AR). This is a relevant consideration, given that fear could very well be an intrinsic component of the emotions that are elicited by stimuli generally considered representatives of core, and particularly AR disgust. In line with this reasoning imprecise labelling of emotional feelings is not uncommon for fear and disgust (Woody and Teachman, 2002), which is not completely surprising given the characteristics of AR elicitors, that seems to reflect the consequence of being contaminated like for instance cues of

death. It was important to understand the underpinnings of both disgust domains but also of fear (i.e., Chapter 7). This part of the study was done in order to be able to eventually test if women with vaginismus would indeed show a stronger overlap in central processing maps between the disorder specific stimuli and AR or core disgust but also to fear. Disorder specific stimuli (i.e., PEN stimuli) could also elicit the feeling of impending fear.

In brief, the results of this part of the study, confirmed that AR and core could be distinguished in terms of brain processing. The right ventrolateral occipitotemporal cortex (VLOT), was functionally coupled to the middle cingulate cortex (MCC), thalamus, and prefrontal cortex (PFC) (medial, dorsolateral), and this coupling was dependent on the disgust domain (core, AR). It can be speculated that fast visual recognition (i.e., VLOT) is coupled with thalamus and MCC due to the arousal of the stimulus material, whereas the coupling of vLOT with PFC is more related to appraisal of the stimulus material (see Chapter 5, for a detailed description of the results) (Borg, de Jong, Renken and Georgiadis, 2013).

In addition to differences in responding as a function of type of disgust elicitor, people show large differences in their tendency to respond with disgust to potential disgust elicitors (propensity) as well as in their appraisal of experiencing disgust (sensitivity). Thus these traits may be important moderators of people's response patterns. In line with this reasoning, differences in disgust traits (disgust sensitivity, disgust propensity) have been found to critically modulate subjective (van Overveld et al., 2009) responses. Specifically, high disgust propensity may increase the probability that stimuli acquire disgust-evoking properties that could lead to avoidance behaviour (de Jong and Muris, 2002). In turn, this avoidance would be specifically pronounced in individuals who appraise the experience of disgust as highly negative (van Overveld et al., 2010).

Here, findings suggested that indeed disgust traits could modulate the disgust response. The rVLOT, which preferentially responded to visual AR, was functionally connected to the MCC, thalamus, and prefrontal cortex, as a function of disgust domain. This connection with the anterior part of MCC was modulated by disgust propensity, which was strongest during AR. The coupling with anterior insula and ventral premotor cortex was less strong, but depended on this domain-trait interaction. Disgust sensitivity modulated left anterior insula activity irrespective of domain, and did not affect functional connectivity. In general these findings give evidence for a frontal-posterior network/response that interacts with disgust propensity, in a distinct way for AR and core disgust.

It needs mention here that the disgust domains core and AR elicitors differed in their potency to elicit fear; AR stimuli were rated as more fear-eliciting than core disgust stimuli. This was not completely unexpected but it is possible that differences

between AR and core disgust at the central level, could, at least partially, be due to fear-related processing. If indeed fear is an intrinsic component of the emotional feelings that are elicited particularly by AR disgust stimuli (compared to core disgust) it is impossible to control for that. It also seems relevant to note, here, that fear and disgust are not properties of the stimulus materials per se. Stimuli might elicit fear because they relate to impending harm, but also because they may give rise to (fear of) contamination. Hence in the present context it may not be very helpful to think in terms of pure emotional feelings, but it is more important to use properly validated stimuli which are well representative of the categories of interest.

These findings are helpful in their own right for providing some evidence that AR and core disgust can be distinguished at the brain network level and that disgust traits moderate the disgust response. Additionally, in the present theme, these findings make a case for including both classes of disgust elicitors and test their potential involvement in sexual pain disorders (Chapter 7).

**Central processing of disorder-specific stimuli & disgust**

Considering the attention given to sex and visual sexual stimulation (VSS), it is surprising to find that relatively few studies have investigated the brain networks in the processing of sex stimuli. Particularly, no study thus far focused on penetration specific stimuli (PEN) in women. Therefore, this study aimed to examine brain responses to this type of specific stimulation in asymptomatic women.

In general, people are rather flexible in how they connect to sex stimuli and thus are expected to vary in their attitudes toward sex. The observation that people may have both negative as well as positive affective judgments about VSS should therefore not be surprising (Laan and Everaerd, 1995; Peterson and Janssen, 2007). However up until now, it remains largely unclear whether the VSS- induced brain activation is most closely associated with the positive or with negative components of people's subjective evaluation of VSS. Germane to this, previous brain imaging studies on the relationship between sex and disgust have shown substantial overlap in VSS- and disgust-induced activation maps (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). This overlap has generally been attributed to arousal and/ or attention phenomena (Walter et al., 2008). Yet, it may also reflect that the VSS similar to disgusting stimuli elicit negative affective associations. Thus in line with the main theme of this thesis, in the present study we included the subjective VSS evaluations and investigated to what extent individual variability in VSS-induced brain activity could be explained by the participants' positive and negative appraisals.

Moreover, research on people's attitudes toward VSS predominantly focused on explicit attitudes, despite the consistent finding that explicit reports are not neces-

sarily concordant with the implicit associations one can have with sex. It may be that autonomous genital responses occur when negative affective evaluations (e.g. aversion) are reported, and this specific discordance is most typical of women (Laan et al., 1994; Spiering et al., 2003). Therefore, here it was tested whether the activated brain networks would be moderated by the strength of the disgust appraisals of PEN.

A rather unexpected finding in this study was that even in a group of asymptomatic women, many brain areas responded to PEN in the same way as they responded to highly aversive disgust stimuli. This large overlap can be related to lack of sexual readiness. Women need time and the right context to feel sexually ready or aroused, thus they might have felt unprepared or at least not ready for such hardcore stimulation. Additionally, in line with the DAMP-model, it could be hypothesized that participants had no time or the right ambient to dampen the disgust by default that is generally present in all women towards penetration-like stimuli. Additionally, the first impression of being presented with penetration stimuli might have felt unexpected, or even inappropriate and shameful.

PEN-induced brain activity was prone to modulation by subjective disgust ratings towards PEN stimuli. To a certain degree this modulation could point to the option that there might be differences between asymptomatic women and women with penetration disorders (see Chapter 6). Moreover, implicit associations modulated exclusively PEN-induced brain responses. That is relatively negative (PEN-disgust) implicit associations with PEN predicted the strongest PEN-related responses in the basal forebrain (including nucleus accumbens), midbrain, and amygdala. These primal areas (deep inside the brain) are often implicated in visual sexual processing, however, the present findings seem to suggest that their involvement may also indicate a negative, avoidant attitude towards PEN stimuli. However, though I use the word "unexpected", it is important to mention that this finding was not completely novel. Previous brain imaging studies employing less explicit erotica have also suggested overlap between the processing of sexual and disgust stimuli (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). This could potentially indicate that general arousal and/or attention occurrences may be an important connecting factor. The overlap is mostly seen in lateral occipitotemporal cortex, superior parietal lobule, ventral pallidum, amygdala, and thalamus.

Related to the findings that sex and disgust induced neural maps seem to overlap both in this study but also in earlier attempts (Karama et al., 2011; Borg, de Jong and Georgiadis, 2013), it could be hypothesized that perhaps women appraise PEN stimuli as negative, especially if they are not sexually ready. Thus, to further explore the appraisal of sex stimuli, perhaps in a more ecologically valid environment, it would be relevant to induce sexual arousal (e.g., by erotic stories/movies) before

exposure to disgust and PEN stimuli, to study if sexual arousal and sexual readiness alter this highly similar pattern of activation at neural level (by proving a more appropriate and sex-congruent environment).

Most important for the present context, these findings clearly indicate that the expected overlap at brain level between disgust and PEN in women with vaginismus seems to already exist in asymptomatic women. Thus the next step was to test if this overlap is stronger for women with penetration disorders versus women with no penetration related problems.

**Vaginismus: neural responding to emotional stimuli**

Finally, it was tested if women with GPPPD particularly with vaginismus would have stronger convergence in their responses toward the sexual (penile-vaginal) PEN- and the disgusting stimuli. In other words, it was tested whether disgust- and PEN-related brain networks would overlap more in women with vaginismus than in asymptomatic women. As discussed previously, core and AR disgust elicitors are both considered as pathogen disgust; but given their different pathways of pathogen transmission, and that both classes are also differentially involved in various psychopathologies (Tybur et al., 2013; Olatunji et al., 2007), in this part of the research project we considered it relevant to investigate whether this similarity is restricted to a specific class of disgust elicitors.

Yet, before discussing the convergence of PEN and disgust brain processing, it seems relevant to first shortly address the processing of PEN stimuli per se. Contrasting, with our initial expectations there were no differences in PEN processing large enough to distinguish between groups. Thus the findings provided no evidence to suggest that the brain activation in response to sexual penetration pictures was fundamentally different in women with sexual pain disorders compared to women without sexual problems. It needs mention here that our a priori expectations were fuelled by the findings described in Chapter 6, in which PEN-induced brain activity was found to be modulated by (implicit and explicit) penetration-disgust associations within the group of women with no sexual complaints. The character of the modulation was in such a way that stronger negative PEN-disgust associations correlated with higher BOLD activation (PEN-induced brain activity). This relationship in healthy controls together with the finding that as a group women with vaginismus or dyspareunia show stronger (implicit and explicit) disgust associations than symptom free control women (Chapter 4) prompted the expectancy that due to their relatively strong penetration-disgust associations the symptomatic women would also show relatively strong BOLD activation in response to penetration pictures. One explanation for the absence of the anticipated

difference could be related to the observation that women across the board seem to appraise PEN rather negative, which then allows little room for between group differences to emerge (ceiling effect). In addition, it should be noted that the modulation of PEN-induced brain activity by implicit PEN-associations in Chapter 6, was restricted to very specific areas (including the right superior parietal lobule, the midbrain, the rostral basal forebrain, and the right amygdala), whereas at this point we only investigated the whole brain in Chapter 7 given the explorative nature of this study. Thus one way to go would be to delve into the brain areas that correlated with PEN-disgust implicit associations in the study described in Chapter 6 and test if these areas specifically distinguish between groups.

Besides the processing of PEN per se, we were especially interested in the convergence of PEN and disgust brain activity. This report extend on the earlier findings described in Chapter 6, were we already demonstrated that core disgust and PEN stimuli generally captured large similarities in their respective neural reactivity (Borg, de Jong and Georgiadis, 2013) which is also consistent with previous work in this field (Stark et al., 2005; Walter et al., 2008; Karama et al., 2011). Namely, in this study it was shown that this convergence in brain-responses between PEN and disgust elicitors is not more pronounced in the clinical groups (i.e., vaginismus or dyspareunia) but was similar for all women independent of group membership. Additionally, this study showed that across groups, the processing of PEN stimuli shared more similarities with the processing of AR-disgust (in deep brain areas) than with the processing of core-disgust elicitors.

As briefly alluded to in earlier sections, this finding can be explained from the perspective of the disease avoidance model of disgust. In that despite core and AR disgust elicitors both inform us about the risk of potential contamination by pathogen transmission, it could be said that they use two different pathways in terms of transmission. Core disgust elicitors are predominantly associated with contamination by oral related ingestions, while AR disgust seems more related to a bodily type of pathogen transmission. The latter type of transmission of pathogens seems most closely related to how penile-vaginal penetration could give rise to pathogen transmission. The finding that the convergence with PEN processing was especially strong for AR stimuli might thus be explained by the shared pathway of potential pathogen transmission (i.e., through body products and body apertures).

At a macro level if you may, the convergence of disgust and PEN is consistent with the idea that indeed disgust could very well be involved in penetration related problems. However, the unexpected finding that this convergence is also similar for women with no specific sexual problems, alters the question of whether disgust is indeed implicated in penetration related disorders, to a more fundamental question of how women still show sexual appetite, despite the disgust mechanism that works

against it (de Jong et al., 2013). A question that we explored in further depth in asymptomatic women (see Chapter 8).

It could be argued that women generally have an ambivalent response to penetration cues, which can be due to the interplay of *avoiding* in order to protect against contamination/transmission of pathogens versus *approaching* to facilitate procreation and pleasure (Stevenson et al., 2011; de Jong et al., 2013). Though one needs to mention here that in terms of pleasure, penile-vaginal penetration for women contrasts with men, in that it is not the common pathways of orgasm as clitoris stimulation is. All this and the fact that this study was conducted in a lab context, specifically in a scanner with limited space or possibility for movement, the negative response is very likely to have overruled, particularly so in the absence of sexual arousal (Borg and de Jong, 2012), which in turn would allow more room for disgust.

Following this line of reasoning, one may wonder how, then, the absence of a between group difference in the degree of convergence between PEN and DISGUST (Chapter 7) relates to the presence of a difference between symptomatic and non-symptomatic women with regard to their implicit and explicit penetration-disgust associations. One explanation could be that it is due to differences in methodological procedures. For example, the stIAT contrasts with passive picture viewing as it brings people in a mode to evaluate pictures along a particular dimension (e.g., disgust to hot, threat to safe). Whereas, in the fMRI study, people were just passively viewing the presented stimuli and were not primed to a particular evaluative mode. As it has been mentioned, in studies in which it was explicitly asked from participants to categorize PEN stimuli on a dimension of disgust-hot, specifically women with penetration disorders (both vaginismus and dyspareunia) displayed strong PEN-disgust associations (Borg et al., 2010). Consistent with such an explanation, a differential pattern between controls and women with penetration disorders is also typically evident for the subjective ratings - that are obviously done in an evaluation mode (Huijding et al., 2011; Borg et al., 2010).

Also consistent with this specific versus more global appraisal of stimuli, these negative associations seem not to be evident when it concerns global affective associations. In fact, the global affective associations seems to be positive across the board (Huijding et al., 2011), whereas it is the more specific associations/evaluative dimension (such as threat and disgust) that gives rise to differential responding between symptomatic and asymptomatic women (Borg et al., 2010).

In conclusion this has been a first attempt to explore the underpinnings of the neural correlates in the processing of negative emotional responses toward penetration stimuli, the latter referred to as disorder specific stimuli throughout this thesis. Moreover, it has been an attempt to have more insights in genito-pelvic pain/penetration disorder which are relatively weakly understood. This study

showed that the convergence in the brain-activity between PEN and disgust in women with no penetration problems reported in Chapter 7 was not more pronounced in women with penetration disorders as initially expected. Yet, within each group, the processing of PEN stimuli shared more similarities with the processing of AR-disgust elicitors, whereas the shared activity was far less pronounced for the core disgust elicitors and virtually absent when compared to the processing of the fear-eliciting stimuli. It can thus be speculated that this overlap seems to reflect a default negative/disgust response towards penetration stimuli across all women, perhaps particularly so in the absence of sexual readiness. A critical next step to confirm if indeed sexual arousal would alter this similarity with disgust - would be to examine the processing of PEN stimuli in women with and without sexual dysfunction following sexual arousal induction.

### 9.3.4 Disgust versus sexual arousal

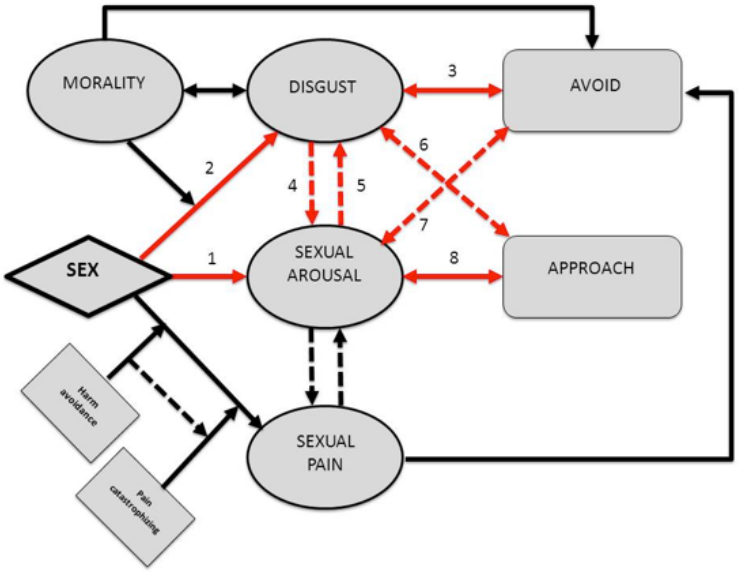



Figure 9.6: The red lines indicate the interplay of sexual arousal and disgust. A sexual stimulus generally elicits sexual arousal (1) which in turn will facilitate approach tendencies (8) and perhaps inhibits the experience of negative emotions such as disgust (5). In addition, sex might also give rise to disgust (2) which could motivate avoidance away from the sexual stimuli (3) and could hinder sexual arousal (4, 6).

*"If you're turned on, you're less likely to be grossed out" ABCnews*

In the previous chapters the potential implications of disgust in women with vaginismus has been discussed, with evidence supporting the idea that indeed disgust might be a relevant factor in the aetiology of vaginismus. This was evidenced by the enhanced disgust responses in women with penetration disorders towards PEN- specific stimuli, both at the subjective, as well as on the more automatic level (Borg et al., 2010). Brain responses were also consistent, in that the brain reactivity captured was similar for both disgust and PEN stimuli, but not stronger in women with penetration disorders when compared to the sexually asymptomatic women. In light of the studies discussed in the previous chapters and consistent with the DAMP-model, the core problems of vaginismus may not be merely related to the enhanced disgust response toward sexual cues, but could also be related to a lack of satisfactory sexual arousal; which in turn might be insufficiently strong to counteract the negative impact of disgust.

When one takes the perspective of the disease avoidance model, this disgust response to PEN stimuli makes sense, because penetration can be a high risk for contamination. On the other hand, strong disgust responses in the context of sexual penetration seem inconsistent with another highly important function, namely the transmission of genes.

In the light of this intimate interplay of sex and disgust, the critical question seems not solely whether disgust may be involved in sexual problems but perhaps a more fundamental question is how people in general show a strong sexual appetite, despite the risks associated with the actual act of penetration, and this is even more emphasized for women. Importantly penile-vaginal penetration has critical phylogenetic relevance in the goal of transmitting optimal genes opposing the adaptive goal of disease avoidance. Thus to facilitate functional and pleasurable sexual behaviour while minimizing health risks, it has been argued that sexual arousal may indeed reduce the disgust properties of otherwise disgusting stimuli (Stevenson et al., 2011). Consistent with this idea, in a correlational study, participants reported less disgust after watching an erotic movie (Koukounas and McCabe, 1997).

Therefore, it can be said that these studies appear to give us some indications of why people still approach these disgusting stimuli, but a question remains unanswered: are these findings restricted to subjective feelings about imagined situations or is sexual arousal indeed successful in increasing people's willingness to actually approach these stimuli (see Figure 9.6). The approach tendencies are particularly relevant here, since disgust characteristically creates distance from the disgusting stimuli and consequently could hinder sexual behaviour. This is also relevant for the symptoms associated with vaginismus, considering the notion that women inflicted with this disorder are typified by avoidance (De Kruiff et al., 2000; ter Kuile

et al., 2007; Borg et al., 2011).

Moreover, the cited studies were mostly restricted to men. Given the main theme of this thesis, but also considering the factors of the evolutionary differential roles of men and women, women's higher sensitivity to disgust, and their higher vulnerability to infections (Fessler et al., 2003; Haidt et al., 1994), it was considered important as a first step to investigate whether these findings are also robust in sexually (asymptomatic) women. This study tested the influence of sexual arousal on the subjective feelings of disgust but also whether sexual arousal would facilitate participants' actual approach towards disgusting stimuli. Moreover, in order to test whether this reduction in disgust properties would be restricted to sexual stimuli or would represent a more general phenomenon that applies to disgusting stimuli in general, stimuli that do not directly refer to sex were also included in the study (see Figure 8.1).

In line with predictions, this study has shown that when sexually aroused, women rated the sex relevant disgusting stimuli less disgusting, when compared both to the neutral and to the positive arousal group. Additionally, for both the sex and the non-sex relevant disgusting (behavioural) tasks, the sexual arousal group conducted the highest percentage of tasks. This indicated that sexual arousal indeed accentuates the actual approach tendencies towards disgusting stimuli. Findings are in line with the earlier attempts (Stevenson et al., 2011), with the small but significant difference that in this current study the effect of induced sexual arousal was also evident for stimuli that do not directly refer to sex. This apparent difference could potentially be attributed to the intensity of the experimental manipulation, as Stevenson and colleagues used passive picture viewing, whilst the current study made use of female friendly erotic film (porna) to elicit sexual arousal. It seems a valid conclusion to draw, that this dampening of disgust is not only relevant/applicable to stimuli referring directly to sex, particularly because when a person is engaged in ''passionate'' sex, there would be more stimuli (not necessarily sex related) that can disturb the functional sexual behaviour (e.g., the scent of the room, or ambiguous stimuli that can be perceived as disgusting).

Thus, these findings clearly demonstrate that sexual arousal also affects women's behaviour and accentuates the actual approach tendencies. This seems particularly relevant here, when one considers that the subjective self-reported disgust does not mediate the impact of the experimental condition on the willingness to approach and conduct the tasks. This suggests that sexual arousal seems to have a largely independent influence on the experience of disgust and on people's tendency to avoid disgust-relevant stimuli. Although participants in the sexual arousal group rated the non-sex relevant stimuli as less disgusting than the neutral control group, such difference was absent between the sexual arousal- and the positive arousal

group. This could indicate that the impact of the sex film on subjective disgust is mainly driven by the generally arousing properties of the film. Hence, the impact of the sex film on the subjective appreciation of sex-relevant disgust elicitors might be driven by its specific power to elicit sexual arousal, whereas its effect on the appreciation of non-sex disgust elicitors might be driven by its generally (sex-independent) arousing properties. The impact of the film on participants' actual approach of sex-relevant and sex-irrelevant disgust elicitors seems specifically driven by its power to elicit sexual arousal, as the sex-irrelevant arousing films did not affect participants' avoidance tendencies (neither for the non-sex nor for the sex-relevant disgusting tasks).

Taken together, the present pattern of findings not only shows that feelings and avoidance of disgust represent (partly) independent phenomena, it also suggests that they are differentially influenced by sexual arousal. These findings seem to indicate that both the impact of heightened sexual arousal on subjective disgust and also on disgust-induced avoidance will act in a way to facilitate the engagement in pleasurable sex. In other words this may help explain why people generally have high appetite for sex despite its opposing forces.

However, these findings are also relevant for the understanding of vaginismus and symptoms surrounding the penetration disorders. This data could suggest that low sexual arousal might be a key feature in the maintenance of symptoms related to penetration problems. As alluded to earlier, if indeed sexual arousal is hindered or it is not up to a satisfactory level, disgust may overrule which could lead to avoidance. The physiological changes that facilitate sexual penetration might also be suppressed leading to more friction and pain with (attempts of) penetration. Whether or not this mechanism is true for women with vaginismus remains to be confirmed, which could be done by simply replicating this study with symptomatic women. Considering the dual process model that distinguishes between the explicit and the more reflexive disgust-avoidance behaviours (Gawronski and Bodenhausen, 2006) it would be relevant to test if this mechanism is also true for the more automatic approach tendencies toward disgusting stimuli. This seems especially relevant, because automatic tendencies or attitudes are assumed to guide the more spontaneous kind of behaviour that seems also critically involved in symptoms surrounding vaginismus (e.g., flinching, and reflexive disgust induced avoidance).

Additionally, to relate these findings back to the core theme of this thesis and to provide further insight in the mechanism at play in women with penetration disorders, one can speculate that it is perhaps possible that for a subgroup of women, sexual arousal is less strong and does not result in a reduction of disgust feelings, nor in an attenuation of the disgust related avoidance tendencies. As previously discussed (see Chapter 4), it has been suggested that women with vaginismus have

responded with disgust during an erotic film (Borg et al., 2010).

One could argue that usually such film would elicit sexual arousal, which in turn could overrule the disgusting properties of close contact (e.g. penetration) (de Jong et al., 2013). Perhaps the finding that disgust persisted in the vaginismus group (compared to the other two groups) might indicate that for these women, either sexual arousal was less easily elicited by the film or that sexual arousal had a relatively weak influence on disgust. It is reasonable to suggest that this could be due to heightened overall implicit concern with disease avoidance (Curtis et al., 2011).

As a following next step to disentangle and investigate these possible explanations, it would be of interest to test if sexual arousal is less easily elicited in these women by inducing sexual arousal - using physiological measurements in addition to the subjective appraisal of sexual arousal in both women with and without sexual pain. Having said that, for the sake of completeness, a recent study should be mentioned, which sheds light on this question. In it, the authors report findings which suggest that despite greater anxiety and feelings of worry, threat, and disgust, women with sexual pain (i.e., dyspareunia) demonstrated genital arousal similarly to women with no sexual pain (Both et al., ISPOG Symposium, 2013). Additional, it could be tested if in women with sexual pain, PEN stimuli perhaps elicit reflexive defenses at the vaginal canal that disrupt sexual readiness and penetration. Furthermore, it would be relevant to test whether sexual arousal is similarly elicited in both groups of women, but that in women with vaginismus sexual arousal has a relatively weak influence on disgust. Findings here can be helpful to untangle further this relationship in symptomatic women.

Of particular interest in line with this sexual arousal-disgust interplay, anecdotal evidence from clinical practice seems to indicate that when women with lifelong vaginismus start a new sexual relationship, it sometimes happens that they manage to have penile-vaginal intercourse with little or no problem. From this angle, one can perhaps speculate on the existence of a "default" disgust that has never been neutralized (e.g., if sex with a partner was not sufficiently arousing - or it was too late to be desensitized). To clarify this with a practical example: because disgust usually diminishes after repeated exposure to a disgusting stimulus, if a woman postpones the habituation of sex-related disgust, it can consequently be reflected as enhanced disgust, or disgust that has never been neutralized (de Jong et al., 2013).

Following this perspective, it would also be interesting to investigate women from strict religious cultures. This can be done in cultures where sex is postponed until after marriage (where even pleasurable self-touching is considered sinful and forbidden), and test if in these populations the prevalence of vaginismus is higher compared to other cultures where disgust by default is neutralized earlier. This could be in the beginning of an intimate relationship when the novel factor of the

relationship drives high sexual arousal and perhaps this provides a medium where sexual arousal overrides disgust and disgust responding. Another possible way to investigate this phenomenon would be to test whether the initial sexual experiences of women with vaginismus were not (sufficiently) arousing or were for some reason postponed in a way that sexual arousal somehow was less optimal (e.g., length of the relationship before first sexual contact, hormonal problems etc.).

## 9.4 Potential avenues of research

The findings presented in this thesis, fit nicely the DAMP-model, but more work must be done and more questions remain to be answered. Efforts to include the limitations and possible future work, was done throughout this chapter, however, here I will briefly highlight other potential avenues for research that were either not mentioned or only briefly brushed on.

After the assimilation of the seven empirical chapters, as a next step it would be critical to further explore the potential role of enhanced disgust in the development of vaginismus, and to test whether the generally enhanced disgust is affected by treatment. If indeed disgust is a trait that sets these women at risk for developing vaginismus rather than being a consequence of the symptoms, one would expect disgust trait to remain largely unaffected by successful treatment (de Jong and Merckelbach, 1998). Moreover, in line with the DAMP-model, women suffering from penetration disorders showed several characteristics that would lower the threshold for experiencing disgust, and, as a consequence, avoidance away from contamination - in response to sexual stimuli. Thus as a subsequent step, it is relevant to test the involvement of disgust pre and post successful treatment in women with sexual pain.

Furthermore, besides the disgust traits that can increase the likelihood of a stimulus to acquire a disgust quality or to evoke a more intense response; in this discussion it was mentioned that the problems with sexual penetration may not necessarily be related to the enhanced disgust response toward sexual stimuli. These problems could also be related to less than satisfactory sexual arousal. That, in turn, might be insufficiently strong to counteract the negative impacts of disgust. In line with this reasoning, in Chapter 8 it was described that indeed sexual arousal impacts the disgust properties and the actual approach. However, we still need to know if this is also true at the more automatic level, especially because this more spontaneous kind of behaviour is at the core of the symptoms surrounding vaginismus. In this regard a study can be designed to elicit sexual arousal (e.g., by erotic stories), in order to test the potential differential effects of sexual arousal on approaching

disgust eliciting properties (as a function of sexual dysfunction); including a physiological measure of sexual arousal and facial electromyography to index the more automatic disgust responses.

More directly applicable to women with penetration related problems, would be the strengthening of the sex-positive-arousal link, in order to counteract the disgust properties of specific sex cues. Another relevant link would be to reduce the disgusting properties and contamination sensitivity/potency of sex stimuli or disgusting stimuli in general. This could either be done with exposure using response prevention (van den Hout et al., 2011), but perhaps also by means of automatic approach training. In line with this idea in Nader Amir's lab, it was found that attention training was successful in the reduction of contamination fear and in increasing behavioural approach, by using such automatic approach training task (Amir et al., 2012). Following this training it would be important to test whether indeed the negative emotions elicited by sexual stimuli in general, or penetration in particular, decreased in disgust properties and contamination fear.

To lean back to the exposure-part of treatment, it deserves mention, here, that from a clinical point of view, in the last couple of years, highly promising treatment for women with vaginismus has been designed and tested (ter Kuile et al., 2010). This treatment focuses on exposure to the feared stimuli (the actual act of penetration). However, though this treatment is successful, based on the main outcome measure of being able to have intercourse, these women still do not find sexual penetration as satisfactory, as women with no sexual problems do. In other words treatment that focuses solely on penetration does not result in sexual rehabilitation. If the pleasure from sex is less than satisfactory, women with a history of vaginismus can restart avoiding or at least seeking sexual contact less frequently. Given that fear is the main emotion that is given attention in this treatment, and the appeared involvement of disgust in sexual pain, it would be helpful to also investigate other emotions such as disgust and fear of contamination as just discussed (e.g., disgust neutralizations of specific body parts and stimuli), together with shame, anxiety and guilt, and then test if post treatment disgust (and the other emotions) is modified. Ultimately, it will be relevant to test if this attenuated disgust has an effect on sexual pleasure, genital sexual arousal and satisfaction. However, until now, most of the studies investigating genital sexual arousal in response to negative mood induction (e.g., disgust, threat, anxiety) seems to suggest that in women with sexual pain, genital (but not mental) arousal stays intact.

However, in spite of genital arousal (which could be in itself a defensive/protective mechanism) other intravaginal reflexes might be involved in the pathophysiology of vaginismus. At present, high resolution solid state infusion manometry, with novel advanced unisensors and circumferential catheters, is used

to measure intravaginal pressure and consequently reflex activity at different levels of the vaginal canal. It can be hypothesized that these reflexes are activated/initiated by genital sexual arousal. Dysfunction of these reflexes could contribute to sexual dysfunction, female sexual pain disorders in particular (Spoelstra et al., ISPOG Symposium, 2013). Furthermore, it would be relevant to test whether sexual arousal is similarly elicited in women with and in women without penetration disorders, but that in women with penetration disorders, sexual arousal has a relatively weak(er) influence on disgust.

## 9.5 Conclusion

At a macro level this thesis helped to strengthen the link between disgust and sex, a link that was previously rather neglected. Moreover, it shed light on how basic elicitors of disgust (core and AR disgust) and penetration specific stimuli (in this thesis referred to as disorder specific stimuli), are processed at the brain level. A number of components implicated in penetration related problems (as visualized in the heuristic DAMP-model) were either tested or else identified as gaps in literature. Notable is the fact that a number of features were found to be somehow implicated in women with penetration related problems (versus asymptomatic women) such as high conservative/low liberal values and lower willingness to participate in particular sex scenarios, which could provide more room for disgust elicitation toward PEN stimuli. In line with the latter, for women with genito-pelvic pain/penetration disorders, penetration stimuli elicited more physiological and automatic disgust responses compared to women with no sexual pain. Though this difference between the clinical and the control groups was absent at the more central processing, which could be related to the large overlap of disgust and PEN stimuli existing also in women with no sexual pain.

All in all, the studies conducted for, and described in, this thesis provide further evidence that disgust is indeed a factor in penetration related dysfunctions. Fuelled by these findings, additional research avenues for genito-pelvic pain/penetration disorders were explored, which could contribute further to our understanding of the theoretical underpinnings for this disorder, as well as provide novel theory-derived starting points for clinical interventions.

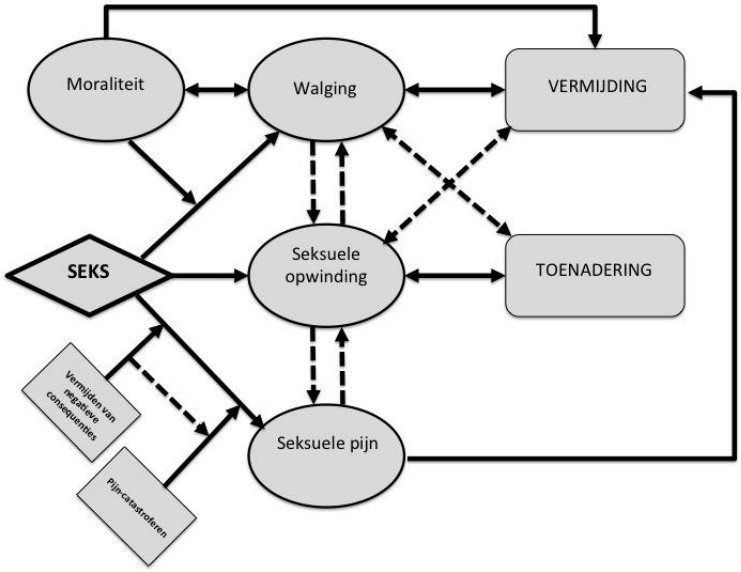
# Samenvatting

Bij de meeste mensen zal seks in eerste instantie vooral positieve associaties oproepen. Er zijn echter ook veel mensen voor wie seks naast positieve allerlei negatieve connotaties heeft. Dit geldt bijvoorbeeld voor vrouwen die pijn ervaren bij pogingen tot geslachtsgemeenschap (dyspareunie) of die uberhaupt niet in staat zijn tot het hebben van geslachtsgemeenschap ondanks het feit dat ze dat heel graag zouden willen (vaginisme)[1]. Onderstaand citaat illustreert hoe de onmogelijkheid tot seksuele gemeenschap de kwaliteit van leven en het emotioneel welbevinden zeer negatief kan beinvloeden.

> *'Ik had een partner die tijdens het voorspel een vinger naar binnen wilde brengen, wat niet lukte. Het was voor mijzelf ook onmogelijk om ooit iets in te brengen. Ik dacht dat ik hierdoor nooit kinderen zou kunnen krijgen..., dit raakte me echt... Ik schaamde me ervoor, en vond het verschrikkelijk dat ik niet elk aspect van seks kon beleven. Tijdens dates moest ik steeds weer aangeven dat ik er niet van hield als er iets bij me naar binnen werd gebracht, zodat ze het niet onverwachts bij me zouden proberen. Ik bedacht me dat ik mijn vagina nooit als een normale vrouw zou kunnen gebruiken. Als het op seks aankwam had ik weinig zelfvertrouwen; ik had het idee niet normaal te zijn..., ik vermeed seks omdat ik bang was dat mijn partner zijn hand te dicht bij mijn vagina zou brengen. Ik was altijd gespannen. Het lijkt wel alsof mijn lichaam altijd in de verdedigingsmodus schiet, alsof ik altijd moet opletten dat ik geen pijn zal lijden... het neemt mijn geest volledig in beslag, en mijn lichaam reageert daarop.'*

Dit proefschrift beschrijft onderzoek naar factoren die mogelijk een rol spelen bij de kwetsbaarheid voor of de instandhouding van aan penetratie-gerelateerde seksuele disfuncties (hoofdstukken 2-8). De focus ligt hierbij op vier centrale componenten: pijn, moraliteit, walging en seksuele opwinding (zie Figuur 9.7)

[1] Vaginisme en dyspareunie vielen in de DSM IV-TR onder de 'seksuele pijnstoornissen'. In de recent uitgekomen DSM 5 zijn deze stoornissen ondergebracht in een bredere categorie van genito-pelvic pain/penetration disorders (GPPPD).




Figuur 9.7: In dit model geven zwarte, ononderbroken pijlen opwinding (+) weer, en de gestippelde pijlen inhibitie (-). Dit model en diens verschillende componenten worden besproken in de algehele discussie, afhankelijk van welk pad relevant is voor het onderzoek dat wordt besproken.

**Pijn:** Het ervaren van pijn tijdens seks, of alleen al de verwachting pijn te zullen gaan ervaren, kunnen aanleiding geven tot allerlei disfunctionele (catastrofale) gedachten zoals 'de pijn zal ondragelijk worden', 'de pijn zal nooit meer ophouden', 'mijn vagina zal beschadigen'. Eerder onderzoek rond chronische rugpijn heeft laten zien dat dit soort gedachten kan leiden tot een overgevoeligheid voor pijn waardoor een neerwaartse spiraal kan ontstaan (pijn > catastrofale gedachten > snellere/sterkere ervaring van pijn > catastrofale gedachten > etc.). Catastrofale pijncognities zouden op dezelfde manier kunnen bijdragen aan de ontwikkeling van seksuele pijnklachten zoals bij GPPPD. Disfunctionele gedachten over pijn zijn waarschijnlijk met name te vinden bij vrouwen die de neiging hebben seksuele gedragingen en stimuli te vermijden die zouden kunnen leiden tot negatieve consequenties ('harm avoidance'), omdat dergelijk vermijdingsgedrag het opdoen van corrigerende ervaringen in de weg staat. Het onderzoek dat is beschreven in hoofdstuk 2 richtte zich op de vraag of vrouwen met vaginisme of dyspareunie zich inderdaad kenmerken door de neiging om catastrofale uitkomsten te verbinden aan het ervaren van pijn, en of ze zich kenmerken door een relatief sterke neiging tot het vermijden van negatieve consequenties (harm-avoidance). De uitkomsten van het onderzoek ondersteunen beide ideëen: vrouwen met vaginisme scoorden hoger op pijn-catastroferen en op harm-avoidance dan de klachtvrije controlegroep. Vrouwen met dyspareunie lieten een vergelijkbaar patroon zien al was het verschil met de controlegroep niet significant.

**Moraliteit:** Hoofdstuk 3 richtte zich op algemene morele waarden en meer specifieke morele opvattingen over seks. Strikte waarden in het algemeen en restrictieve normen met betrekking tot seksueel gedrag in het bijzonder zouden seksueel plezier in de weg kunnen staan en zelfs kunnen bijdragen aan het ontstaan van seksuele problemen. Om de relevantie te onderzoeken van restrictieve waarden en normen voor seksuele pijnstoornissen, vulden vrouwen met vaginisme of dyspareunie twee vragenlijsten in: de Schwartz Value Scale (SCS) en de Sexual Beliefs Questionnaire (SBQ). Zoals verwacht scoorden vrouwen met vaginisme inderdaad relatief laag op liberale waarden en relatief hoog op conservatieve waarden. Ook bleken ze striktere specifieke opvattingen rond seksuele gedragingen te hebben. Daarnaast gaven ze aan minder bereid te zijn tot bepaalde (hypothetische) seksuele gedragingen dan vrouwen zonder seksuele problemen, zoals een video bekijken waarin de eigen partner aan het masturberen is of het zelf aanraken/bestuderen van seksuele speeltjes. Vrouwen met dyspareunie hadden vergelijkbare opvattingen zij het minder uitgesproken en niet significant verschillend van de klachtvrije controle groep.

**Walging:** Hoofdstuk 4 richtte zich op de mogelijke rol van walging bij GPPPD. Alhoewel walging doorgaans niet het eerste is wat bij mensen opkomt als ze denken aan seks, zou walging wel degelijk een relevante factor kunnen zijn bij seksueel gedrag in het algemeen en seksuele disfuncties in het bijzonder. Bepaalde lichaamsproducten en lichaamsdelen die een belangrijke rol spelen in ons seksuele gedrag behoren immers tot de sterkste walg-uitlokkers; denk bijvoorbeeld aan speeksel, zweet, haar, sperma, en lichaamsgeur. Daarnaast kenmerkt walging zich door een aantal reacties die seksueel plezier in de weg zouden kunnen staan zoals sterk negatieve gevoelens en defensieve reflexen die het genereren van seksuele opwinding mogelijk belemmeren en die kunnen bijdragen aan de neiging seksuele stimuli te vermijden. De studie die is beschreven in hoofdstuk 4 toetst de hypothese dat vrouwen met vaginisme of dyspareunie een relatief sterke walg-respons vertonen in reactie op het zien van stimuli die zijn geassocieerd met seksuele penetratie (geslachtsgemeenschap). Mogelijk maakt het aanspannen van de bekkenbodemspieren onderdeel uit van de door walging uitgelokte defensieve reacties wat de problemen met/tijdens penetratie zou kunnen verklaren.

Om te onderzoeken of seksuele penetratie stimuli specifiek bij vrouwen met seksuele pijnstoornissen een relatief sterke automatische associatie oproept met walging, is gebruik gemaakt van zogenaamde Impliciete Associatie Testen (IAT). Om te exploreren of vrouwen met GPPPD penetratie wellicht meer in het algemeen associeren met negatieve uitkomsten werden naast walging-associaties ook dreiging-associaties gemeten. Daarnaast bekeken de deelnemers een vrouwvriendelijke pornofilm. Tijdens het kijken naar deze film werd het EMG gemeten van de levator alesque nasii, de spier die we gebruiken om de neus op te trekken zoals bij de voor walging kenmerkende faciale expressie.

In overeenstemming met het idee dat walging betrokken is bij GPPPD lieten zowel vrouwen met vaginisme als vrouwen met dyspareunie relatief sterke automatische penetratie-walging associaties zien. Dus anders dan de klachtvrije vrouwen associeerden vrouwen met vaginisme of dyspareunie penetratie stimuli sneller met de categorie 'vies' dan met de tegenovergestelde categorie 'lekker'. Op expliciet (zelfrapportage) niveau lieten alleen de vrouwen met vaginisme een relatief sterke walg-associatie zien met penetratie. Kennelijk

stellen de vrouwen met dyspareunie de initiële associaties bij, terwijl vrouwen met vaginisme ook wanneer ze tijd hebben om over hun automatische associaties na te denken volharden in hun walgappreciatie. Wellicht kan dit vermogen van vrouwen met dyspareunie om de initiele walging-associaties uiteindelijk bij te stellen tevens verklaren waarom vrouwen met dyspareunie in tegenstelling tot vrouwen met vaginisme wel in staat zijn tot geslachtsgemeenschap (zij het met pijn).

De vrouwen met een seksuele pijnstoornis vertoonden daarnaast sterkere associaties tussen penetratie en dreiging dan tussen penetratie en veilig. Echter, vrouwen zonder pijnstoornis lieten een vergelijkbaar patroon zien. In deze symptoom-vrije controle groep lag het IAT effect dicht bij 0, wat kan duiden op een ambivalente attitude ten opzichte van penetratie. De afwezigheid van een verschil in automatische dreiging-associaties tussen vrouwen met en zonder seksuele problemen kan mogelijk verklaard worden door het expliciete karakter van de geselecteerde penetratie plaatjes. Omdat de plaatjes bovendien werden vertoond in de afwezigheid van seksuele opwinding, waren de penetratie-dreig associaties waarschijnlijk relatief toegankelijk voor alle deelnemers. Zelfrapportage liet zien dat vrouwen zonder seksuele pijnstoornis de dreig-associaties bijstelden, terwijl de vrouwen met een seksuele pijnstoornis ook op expliciet niveau de penetratie stimuli als relatief bedreigend beoordeelden. Dit suggereert dat de negatieve subjectieve (expliciete) appreciatie van penetratie mogelijk betrokken is bij het ontstaan en/of voortduren van seksuele pijnstoornissen.

Tijdens het kijken naar de vrouw-vriendelijke porno film, lieten de vrouwen met vaginisme verhoogde EMG-activiteit zien van de levator alesque nasii ('walgspier'). Dit patroon was afwezig bij vrouwen met dyspareunie en vrouwen zonder pijnstoornis. Dat de verhoogde EMG-activiteit alleen optrad bij de vaginisme groep zou er op kunnen duiden dat vrouwen met vaginisme wellicht relatief sterk met spierreflexen reageren op walging. Dit zou goed kunnen verklaren waarom specifiek vrouwen met vaginisme niet in staat zijn tot geslachtsgemeenschap ondanks dat zowel vrouwen met dyspareunie als vaginisme walging ervaren tijdens blootstelling aan penetratie plaatjes.

**Walging, seks en het brein:** De studies beschreven in hoofdstuk 5, 6 en 7 waren opgezet om te onderzoeken of bij vrouwen met vaginisme (of dyspareunie) er een overeenkomst zou zijn in het patroon van hersenactiviteit (fMRI) tijdens het kijken naar penetratie stimuli en het kijken naar plaatjes van walgelijke stimuli. Als eerste stap richtte de fMRI studie in hoofdstuk 5 zich primair op de neurale correlaten van walging in het brein bij klachtvrije personen. Huidige theorieen over walging maken onderscheid tussen verschillende categorieën walg-uitlokkers met 'core' en 'animal-reminder' als twee prominente categorieen. Ter onderstreping van de relevantie van dit onderscheid voor de huidige context heeft eerder onderzoek laten zien dat de betrokkenheid van walging bij bepaalde vormen van psychopathologie veelal categorie-specifiek is; dus bij sommige vormen van psychopathologie speelt juist animal-reminder walging een rol, terwijl bij andere vormen van psychopathologie juist core walging meest betrokken lijkt. Om te kunnen uitzoeken of die verschillende categorieën walg-uitlokkers wellicht ook verschillen in hun neuronale correlaten is in deze studie gebruik gemaakt van beide categorieën walg-uitlokkers. Deelnemers kregen aldus niet alleen plaatjes te zien van bedorven voedsel, vieze wc's en dergelijke ('core' disgust), maar ook plaatjes

van verwondingen, verminkte lichamen en bloed ('animal-reminder' disgust). Tevens is de Disgust Propensity and Sensitivity Scale (DPSS) meegenomen als maat voor individuele verschillen in walgingsgeneigdheid (hoe snel iemand in het algemeen van iets walgt) en walgingsgevoeligheid (in welke mate iemand het in het algemeen akelig vindt om walging te ervaren). Kort samengevat lieten de resultaten zien dat animal-reminder en core walging van elkaar kunnen worden onderscheiden op het niveau van geactiveerde hersennetwerken. Daarnaast lieten de bevindingen zien dat de door walging uitgelokte hersenrespons samenhing met zowel walgingsgeneigdheid als walgingsgevoeligheid.

De studie beschreven in hoofdstuk 6 onderzocht hoe vrouwen zonder seksuele problemen reageren op penetratie stimuli. Onverwacht bleek er in deze groep klachtvrije vrouwen een substantiele overlap te zijn tussen de activiteit van hersengebieden uitgelokt door penetratie en de activiteit uitgelokt door walgelijke stimuli. Dat penetratie stimuli zeer vergelijkbare hersenactiviteit uitlokten als universele walg-stimuli is wellicht te herleiden tot de motivationele toestand van de deelnemers in deze artificiele laboratoriumcontext. Het is goed denkbaar dat bij gebrek aan bereidheid tot seksuele activiteit (zoals waarschijnlijk het geval in deze context) penetratie stimuli walging oproepen. Het bleek dat de sterkte van de door penetratie getriggerde hersenactiviteit inderdaad samenhing met zowel meer automatische als meer expliciet overwogen associaties van penetratie met walging.

In hoofdstuk 7 is vervolgens getest of vrouwen met vaginisme of dyspareunie een nog sterkere samenhang vertonen in de hersenresponsen uitgelokt door penetratie- en walgstimuli dan de klachtvrije controlegroep. Dit bleek niet het geval. De overlap in hersenreactiviteit tussen penetratie- en walg- penetratie stimuli bleek vergelijkbaar voor alle groepen. Wel verschilde de overlap als functie van het type walg-stimulus: de overlap in reactiviteit tussen penetratie- en walgstimuli was groter voor animal-reminder stimuli dan voor corewalg stimuli. Deze bevinding kan mogelijk verklaard worden met behulp van het ziektevermijdingsmodel van walging. Voor beide categorieen walg-stimuli wordt verondersteld dat de uitgelokte walging nuttig is om besmetting te voorkomen. Echter, core walging lijkt primair relevant voor besmetting via orale inname, terwijl animal-reminder walging meer relevant lijkt voor besmetting via specifieke lichaamsdelen, zoals mogelijk het geval is bij vaginale penetratie via de penis. De relatief sterke overlap in hersenactiviteit tussen penetratie en animal-reminder walgstimuli zou dus verklaard kunnen worden door een gedeeld pad van potentiele overdracht van ziekteverwekkers.

De gevonden samenhang tussen walging en penetratie is consistent met het idee dat walging een rol speelt bij aan penetratie-gerelateerde problematiek. De onverwachte bevinding dat deze convergentie echter ook optrad bij vrouwen zonder seksuele problemen, transformeert de vraag naar de rol van walging bij vaginisme/dyspareunie in de misschien nog wel fundamentelere vraag hoe het uberhaupt mogelijk is dat vrouwen probleemloos seks kunnen hebben. Anders gezegd: hoe kan het dat vrouwen (en mannen) een sterk seksueel verlangen kunnen ervaren, ondanks de risico's die met seksuele gemeenschap gepaard kunnen gaan. Deze vraag staat centraal in de studie beschreven in hoofdstuk 8.

**Walging versus seksuele opwinding:** De bevindingen van hoofdstukken 6 en 7 suggereren dat walging een normale reactie is van vrouwen op penetratie stimuli. Enerzijds lijkt

dit een adaptieve reactie, omdat seks in het algemeen en geslachtsgemeenschap in het bijzonder vrouwen kwetsbaar maakt voor besmetting met ziekteverwekkers. Anderzijds is door walging geïnduceerde vermijding van geslachtsgemeenschap disfunctioneel omdat het niet alleen belangrijk is om ziekten te voorkomen, maar ook om genen over te dragen aan volgende generaties. Om te verklaren hoe het kan dat we toch seks hebben ondanks het feit dat het een evidente manier is om ziekteverwekkers over te dragen, is geopperd dat seksuele opwinding hier wellicht een 'poortwachtersfunctie' heeft. In de afwezigheid van seksuele opwinding heeft walging mogelijk de overhand tijdens blootstelling aan penetratie hetgeen bijdraagt aan het reduceren van gezondheidsrisico's via het stimuleren van vermijdingstendenties. Echter, onder invloed van seksuele opwinding zou de standaard walg-reactie kunnen worden geremd om aldus de weg vrij te maken voor seksueel toenaderingsgedrag. Dus onder invloed van seksuele opwinding krijgt het adaptieve doel van gentransmissie mogelijk tijdelijk voorrang op het doel van ziektevermijding. Seksuele opwinding zou zo de bereidheid vergroten tot het nemen van gezondheidsrisico's via het hebben van intiem contact met een ander persoon.

Om de houdbaarheid van deze verklaring op waarde te kunnen schatten is in de laatste studie van deze these (hoofdstuk 8) onderzocht of de aanwezigheid van seksuele opwinding er inderdaad voor zorgt dat deelnemers walgelijke stimuli minder walgelijk gaan vinden en meer bereid zijn die stimuli ook daadwerkelijk aan te raken (dus vermijdingsgedrag te reduceren). De resultaten laten zien dat het experimenteel oproepen van seksuele opwinding via het vertonen van een pornofilm inderdaad leidde tot minder walging en tot minder vermijding in een reeks aan walging-gerelateerde taken (bijvoorbeeld het drinken uit een kopje met een insect op de bodem; het aanraken van een koeienoog; het aanraken van gelubriceerde condooms). De walg-reducerende effecten van seksuele opwinding bleken a-specifiek en dus niet beperkt tot evident aan seks gerelateerde stimuli. Al met al ondersteunen deze bevindingen het idee dat seksuele opwinding een poortwachtersfunctie vervult en de standaard walg-respons op penetratie-gerelateerde stimuli tijdelijk kan uitschakelen.

De relatie tussen seksuele opwinding en walging voor seksuele stimuli is mogelijk ook relevant voor het begrijpen van de rol van walging bij GPPPD. Relatief lage seksuele opwinding tijdens (pogingen tot) geslachtsgemeenschap of ander seksueel intiem gedrag speelt mogelijk een sleutelrol bij de instandhouding van de klachten. Wanneer seksuele opwinding belemmerd wordt of niet tot een behoorlijk niveau gebracht kan worden, kan walging ervoor zorgen dat de neiging tot toenadering afneemt, wat weer tot vermijding kan leiden. De fysiologische veranderingen die gepaard gaan met opwinding en die seksuele penetratie normaliter bevorderen kunnen ook verminderd zijn, wat tot meer frictie en pijn bij (pogingen tot) penetratie kan leiden. Of dit veronderstelde mechanisme ook daadwerkelijk een rol speelt bij vrouwen met vaginisme of dyspareunie zal toekomstig onderzoek moeten uitwijzen.

**Translated** by Dr. J. Verwoerd and Prof. P. J. de Jong
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# Recap

Sex in general has for long left the exclusiveness of the bedroom and has become a hot conversational topic among many. Yet, when we talk about sexual problems, what is expected from us and what is considered dysfunctional remains to be a taboo. Problems with sexual (penile-vaginal) penetration, for instance the inability to insert anything in the vagina from a tampon to a partners' penis (vaginismus), or pain with attempts of intercourse (dyspareunia) can be the cause of emotional distress, not only for the woman inflicted with these disorders, but, also for the partner that is met with rejection and negative emotionality with each attempt of penetration. Moreover, in some countries the inability to have penile-vaginal penetration, is still the cause of unconsummated marriages, which will emphasize the distress women go through. The excerpt below illustrates how painful intercourse or the inability to have sexual intercourse may have a serious negative impact on the quality of life, and overall emotional well-being.

> *'I had a partner who tried to insert a finger during foreplay and was unable. I also was unable to ever insert anything myself. I thought I would never be able to have children because of it ... this seriously affected me ... it was embarrassing to not be able to experience every part of sex. I had to tell when I dated that I did not like insertion so they did not try it unexpectedly on me... I figured I would never be able to use my vagina as normal women did. I had low self-esteem when it came to vaginismus because I felt I was not normal... I avoided sex... because I was afraid my partner would by accident put his hand too near my vagina which would cause me to tense up. ...It's like my body always goes into protective mode and I have to make sure I don't get hurt,... it is just this feeling... and its so strong that it takes over my mind and my body reacts to it.'*

In a series of seven empirical chapters (Chapter 2 to Chapter 8) included in this doctorate thesis, features that can be involved in the vulnerability for, or the maintaining symptoms in penetration related disorders were explored. Mainly, four central pathways were investigated, namely, pain, morality, disgust and sexual arousal (see Figure 9.1). Disgust was given the most attention in this thesis as one of the prominent candidates for negative emotional

responding towards sexual stimulation (de Jong et al., 2009; Borg et al., 2010; de Jong et al., 2013; Borg, de Jong and Georgiadis, 2013). Obviously, many other features not covered here in this dissertation, may be directly or indirectly involved in the aetiology and maintenance of penetration related problems (e.g., relationship issues, co-morbidity with other psychological difficulties, traumatic experiences etc.).

Before the main 4 pathways are summarized, it needs mention, that when we started working on this project (in year 2009), these two disorders were under the heading of 'sexual pain disorders' in the DSM-IV-TR, and just recently were incorporated under a broader newer heading, namely 'genito-pelvic pain/penetration disorders' (GPPPD) for the newer version of the DSM. Therefore, we often mentioned vaginismus and dyspareunia in our writing, but also penetration related disorders, especially when we were referring to both disorders together, as the pooled clinical groups.

**Pain:** In women with vaginismus, (anticipation of) sexual pain may give rise to catastrophic ideation (Reissing, 2009). Evidence suggests that this same anticipation of catastrophic consequences may well contribute to hyper-vigilance towards painful sexual stimuli, which further contributes to a negative appraisal of sexual cues, and avoidance (Lykins et al., 2011; Payne et al., 2005). Additionally, attempts of penetration that are met with increased muscle tone may add to the negative cognitions, kind of reinforcing the dysfunctional beliefs. One would expect that women who show a habitual tendency to make such catastrophic interpretations of pain, are then also likely to apply a similar strategy to situational pain during penetration. Accordingly, if indeed dysfunctional pain cognitions play an important role in the aetiology and maintenance of penetration disorders, women with high pain catastrophic cognitions (PC) would be especially vulnerable to these symptoms.

Consistent with this line of reasoning, in the present study women with vaginismus showed higher PC scores when compared to both women with no sexual pain and to women with dyspareunia (Borg et al., 2011). In addition, the findings described in (see Chapter 2), indicated that, compared to sexually asymptomatic women, women with vaginismus scored higher on harm avoidance (HA). This is consistent with the view that catastrophic appraisal of anticipated pain, may promote hyper-vigilance to pain and avoidance behaviour. Additionally, the finding that these women were inclined towards higher scores on HA (compared to the dyspareunia group) is in line with evidence indicating that women with vaginismus display stronger defensive reactions during gynecological examinations than women with dyspareunia do (Reissing et al., 2004). According to the proposed DAMP-model (See Figure 9.2), both PC cognitions and trait HA could jointly contribute to strengthen the link between sexual cues and (anticipation of) pain by eliciting further catastrophe avoidance type of behaviour. This avoidance might inhibit sexual arousal, which perhaps due to low physiological preparation increases pain. The combined presence of high PC and high HA was most predictive for the presence of vaginismus. These findings are consistent with the idea that women with both high PC as well as high HA might be especially at risk for developing and maintaining the vicious cycle of vaginismus.

It should be noted, that in the present research project we did not actually measure whether sexual stimuli (e.g., attempts of penetration) would give rise to pain. Hence, these

findings though consistent with the proposed DAMP-model (see Figure 9.2), are not in itself supporting this particular way in which PC is integrated in it.

**Morality:** Also strong adherence to moral values might be involved in penetration disorders. Evidence suggests that strict moral principles, perhaps triggered by conservative cultures (e.g., women forbidden to have any pleasurable self-touching), strict religious beliefs (e.g., sex before marriage is considered sinful) or lack of appropriate or inaccurate education (e.g., masturbation is linked to infertility, and penetration is painful), has for long been associated with vaginismus (Silverstein, 1989; Ward and Ogden, 1994).

Having more restrictions around sex, may increase the inclination to frame sexual cues as wrongdoing. When one is transgressing (doing something wrong), it is natural to feel guilt, shame but also disgust. In fact, evidence suggests that transgressing socio-moral values is a powerful cue for the elicitation of disgust (Chapman et al., 2009; Zhong and Liljenquist, 2006). The elicited disgust as a reaction to transgression is found to be highly similar to the disgust that a rotten piece of meat (core/pathogen disgust) would elicit. Moreover, the disgust triggered by transgressions, may amplify the already existing restrictive sexual attitudes (Schnall et al., 2008). In line with expectations, the findings from Chapter 3, indicated that specifically the vaginismus group showed relatively low scores on liberal values combined with comparatively high scores on conservative values when compared to asymptomatic women (Borg et al., 2011). Moreover, women with vaginismus were (sexually) more restricted in their willingness to participate in particular sex-related behaviours (e.g., watch a video clip in which your partner is masturbating, touch and carefully examine a sex aid). The position of the dyspareunia group, also shows relatively less willingness to participate in certain sex-related behaviours and more adherence to conservative/less adherence to liberal values, but not significantly different from neither the vaginismus group nor from the asymptomatic women.

**Disgust:** The third factor that is addressed in this thesis is disgust. In the last years, it has been proposed that disgust and fear of contamination may be involved in vaginismus (de Jong et al., 2009; Borg et al., 2010; de Jong et al., 2013; Cherner and Reissing, 2013). Relevant for the theme of this thesis, is the evidence suggesting that various body parts and body products that are directly involved in sex, differ in their contamination sensitivity and disgust potency. For instance the mouth, vagina, and penis hold the highest subjective contamination sensitivity, alongside sweat, saliva and semen, which are considered amongst the strongest disgust elicitors (Rozin and Fallon, 1987). Moreover, disgust is highly associated with avoidant tendencies and defensive reflexes that may help to protect and to avoid (the anticipated) contamination (Yartz and Hawk, 2002). In this reasoning, the prospect of mere physical contact with the vagina and/or the anticipation of penetration by the partner's penis may elicit flinching given the high risk of contamination associated with penetration (Rozin et al., 1995; van der Velde et al., 2001). Consistent with this, previous research has revealed that women with vaginismus score high on disgust propensity (i.e., how often a person is likely to experience disgust) (de Jong et al., 2009). However, it remains to be tested whether indeed penetration stimuli elicit strong disgust responses in women with vaginismus. Besides, the results discussed in this summary exclusively relied on explicit self-report

measures.

Of relevance here is what social psychologists refer to as the dual process model, which emphasizes the importance to differentiate between the deliberate, reflective attitudes (that can indeed be measured with self-reports) and the more automatic reflexive associations in memory that play an important role in guiding spontaneous (reflexive) behaviours (Gawronski and Bodenhausen, 2006). Following such dual process perspective, it seemed reasonable to assume that especially the more automatically activated associations are most relevant in vaginismus (e.g., defensive reactions). Indeed women with vaginismus had stronger automatic penetration-disgust associations than women without sexual problems. In other words, they associated more quickly penetration stimuli with disgust rather than with 'hot'.

Considering that in clinical research, vaginismus has recently been depicted as a penetration-specific phobia (Binik et al., 2010; ter Kuile et al., 2009), it seems reasonable, not only to anticipate PEN-disgust related associations, but also penetration-threat related associations (van der Velde et al., 2001). In line with this, the strength of the implicit association task effects (i.e., st-IAT, which is validated reaction time task) was very similar for penetration-threat and penetration-disgust associations within the two clinical groups (i.e., vaginismus and dyspareunia). In other words, also threat associations were present for these women. Yet, rather unexpectedly the strength of the penetration-threat associations was not different from that of women with no sexual pain. In this group the st-IAT effect was close to zero, which might indicate that they have an ambivalent attitude or at the very least not a strong penetration-safe (vs. threat) attitude.

The absence of a difference in automatic threat associations in women with and without sexual pain disorders may be due to the explicit character of the applied (penile-vaginal) penetration pictures which might refer to a more general threat value such as the risk of transmission of pathogens (perhaps because the vagina is an explicit body apertures) (Oaten et al., 2009; de Jong et al., 2013) or sexual violence. The threshold for eliciting these types of threatening associations might have been especially low because of the absence of sexual readiness when participants processed these stimuli. Also the lab-context (penetration-incongruent) might have contributed to this rather negative appraisal (van der Velde et al., 2001). Thus it might still be that there are differences between groups with regard to their penetration-threat associations - given the proper context (and/or in the presence of sexual arousal).

It should be acknowledged, that the enhanced automatic PEN-disgust associations were not restricted to women with vaginismus but were also evident in women suffering from dyspareunia (Borg et al., 2010). This pattern of findings may help explain the shared difficulties associated with vaginal penetration (either completely impossible in vaginismus or partially possible but with pain in dyspareunia). Also, this seems to be in line with clinical reviews that reinforce the difficulty to draw a clear line between dyspareunia and vaginismus. Given these difficulties to make a clear distinction between the two disorders, experts in the field promoted the idea that these conditions can be better taken under one umbrella of genito-pelvic pain/penetration disorder (GPPPD) (Binik et al., 2010), rather than keeping them as two separate entities (Cherner and Reissing, 2013), which is now the case for the current DSM, despite that debate continues about this categorization. Conceivably this distinction is

dependent on the criteria used for diagnosis.

In this same study we also recorded facial electromyography (EMG) of the facial levator labii muscle (i.e., the muscle that we use when we wrinkle our nose in disgust) as a unique physiological marker of disgust (Vrana, 1993). Underlining the potential importance of reflexive disgust response in vaginismus, here it was revealed that specifically the vaginismus group responded with an increase of levator activity in response to the erotic stimulation. Conceivably, the increased facial levator activity could indicate that women with vaginismus respond with a more intense general muscular (disgust-induced) defensive response when compared to women with dyspareunia (van der Velde et al., 2001).

The vaginismus and the dyspareunia group differed also on their subjective ratings of the PEN related stimuli. Specifically women with vaginismus appraised the PEN stimuli as more disgusting compared to the other two groups and more threatening when compared to the women with penetration disorders (but not from the dyspareunia group). Apparently, in the vaginismus group, in contrast to the dyspareunia group, the validation process does not give rise to a correction of the initial (PEN-disgust) association. Perhaps this may help explain why penetration is still possible in dyspareunia despite the pain, but not in vaginismus.

*Disgust and disorder specific stimuli at the brain level:* The following three (parts of) studies were designed to ultimately investigate whether women with vaginismus would indeed show a different pattern of activity to disorder-specific stimuli, that would more strongly resemble disgust responses (i.e., a stronger overlap in central processing maps in women with vaginismus) when compared to the other two groups, that is women with no sexual pain and dyspareunia, respectively (see Chapter 7). Yet, in order to be able to examine this hypothesis, we have included two secondary studies (Chapter 5, and 6). The first study tapped on the neural correlates of disgust as a function of the disgust domain and as a function of trait disgust. In brief, the results of this part of the study, confirmed that two disgust domains, namely animal reminder (AR) and core disgust could be distinguished in terms of brain processing. Moreover the findings suggested that disgust traits (disgust propensity and disgust sensitivity), modulated the disgust-induced brain responses. The second study examined how asymptomatic women respond to penile-vaginal PEN pictures. Even in this group of sexually asymptomatic women, many brain areas responded to PEN in the same way as they responded to highly aversive disgust stimuli. This large overlap might be related to lack of sexual readiness. Women need time and the right context to feel sexually ready, thus they might have felt unprepared or at least not ready for such hardcore stimulation. Importantly, PEN-induced brain activity was prone to modulation by both implicit and explicit PEN-disgust associations.

Finally, it was tested if women with vaginismus would have stronger convergence in their responses toward the sexual (penile-vaginal) PEN and the disgusting stimuli. In this part of the project it has been shown that this convergence in brain-responses between PEN and disgust elicitors is not more pronounced in the clinical groups (i.e., vaginismus or dyspareunia), but seems to be rather similar for all women independent of group membership. Additionally, this study showed that across groups, the processing of PEN stimuli shared generally more similarities with the processing of AR-disgust than with the processing of core-disgust

elicitors.

This finding can be explained from the disease-avoidance model of disgust. Although core and AR disgust elicitors both inform us about the risk of potential contamination by pathogen transmission, core disgust elicitors seem predominantly associated with contamination by oral related ingestions, whereas AR disgust seems more related to a bodily type of pathogen transmission. The latter type of transmission of pathogens seems most closely related to how penile-vaginal penetration could give rise to pathogen transmission. The finding that the convergence with PEN processing was especially strong for AR stimuli might thus be explained by the shared pathway of potential pathogen transmission (i.e., through body products and body apertures). At a macro level if you may, the convergence of disgust and PEN is consistent with the idea that indeed disgust could very well be involved in penetration related problems. However, the unexpected finding that this convergence is also similar for women with no specific sexual problems, alters the question of whether disgust is indeed implicated in penetration related disorders, to a more fundamental question of how women still show sexual appetite, despite the disgust mechanism that works against it (de Jong et al., 2013). This question was explored in further depth in asymptomatic women (see Chapter 8).

It could be argued that women generally have an undecided or even negative response to penetration cues, which can be due to the interplay of *avoiding* in order to protect against transmission of pathogens versus *approaching* to facilitate procreation and pleasure (Stevenson et al., 2011; de Jong et al., 2013). Though in terms of pleasure, penile-vaginal penetration for women contrasts with men, in that it is not the common pathways of orgasm as clitoris stimulation is. All this and the fact that this study was conducted in a lab context, specifically in a scanner with limited space or possibility for movement, the negative response is very likely to have overruled, particularly so in the absence of sexual arousal (Borg and de Jong, 2012), which in turn would allow more room for disgust.

Disgust vs. **sexual arousal:** Triggered by the findings of Chapter 7, the core problems of vaginismus may not be merely related to the enhanced disgust response toward sexual cues, but could also be related to a lack of satisfactory sexual arousal; which in turn might be insufficiently strong to counteract the negative impact of disgust. As argued in the previous chapters (see Chapter 5) if indeed penetration stimuli are processed similarly to disgust stimuli across groups (at least at brain level), though this makes sense from a disease-avoidance perspective, disgust responses in the context of sexual penetration seem inconsistent with another highly important function, namely the transmission of genes. In the light of this intimate interplay of sex and disgust, a more fundamental question that might arise is how people in general show a strong sexual appetite, despite the high risks associated with sexual intercourse. Importantly penile-vaginal penetration has critical phylogenetic relevance in the goal of transmitting optimal genes opposing the adaptive goal of disease avoidance. Thus to facilitate functional and pleasurable sexual behaviour while minimizing health risks, it has been argued that sexual arousal may indeed reduce the disgust properties of otherwise disgusting stimuli (Stevenson et al., 2011).

But what remained unanswered from these earlier attempts, is whether these findings are restricted to subjective feelings about imagined situations, or if sexual arousal indeed is suc-

cessful in increasing people's willingness to actually approach these stimuli. The approach tendencies are particularly relevant here, since disgust characteristically creates distance from the disgusting stimuli and consequently could hinder sexual behaviour. This is also relevant for the symptoms associated with vaginismus, considering the notion that women inflicted with this disorder are typified by avoidance (De Kruiff et al., 2000; ter Kuile et al., 2007; Borg et al., 2011). Thus, given the main theme of this thesis, but also considering the factors of the evolutionary differential roles of men and women, women's higher sensitivity to disgust, and their higher vulnerability to infections (Fessler et al., 2003; Haidt et al., 1994), it was considered important as a first step to investigate whether these findings are also robust in (asymptomatic) women. This study tested the influence of sexual arousal on the subjective feelings of disgust and also whether sexual arousal would facilitate participants' actual approach towards disgusting stimuli.

In line with predictions, this study has shown that when sexually aroused, women rated the sex relevant disgusting stimuli less disgusting, when compared both to the neutral and to the positive arousal group. Additionally, for both the sex and the non-sex relevant disgusting (behavioural) tasks, the sexual arousal group conducted the highest percentage of tasks. This indicated that sexual arousal indeed accentuates the actual approach tendency towards disgusting stimuli. Findings are in line with the earlier attempts (Stevenson et al., 2011), with the small but significant difference that in this current study the effect of induced sexual arousal was also evident for stimuli that do not directly refer to sex. This apparent difference could potentially be attributed to the intensity of the experimental manipulation, as Stevenson and colleagues used passive picture viewing, whilst the current study made use of female friendly erotic film (porna) to elicit sexual arousal. It seems a valid conclusion to draw, that this dampening of disgust is not only applicable to stimuli referring directly to sex, particularly because when a person is engaged in 'passionate' sex there would be more stimuli (not necessarily sex related) that can disturb the functional sexual behaviour or mood (e.g., the scent of the room, or ambiguous stimuli that can be perceived as disgusting).

These findings seem to indicate that both the impact of heightened sexual arousal on subjective disgust and also on disgust-induced avoidance will act in a way to facilitate the engagement in pleasurable sex. However, these findings are also relevant for the understanding of vaginismus and symptoms surrounding penetration disorders. This data could suggest that low sexual arousal might be a key feature in the maintenance of symptoms related to penetration problems. As alluded to earlier, if indeed sexual arousal is hindered or it is not up to a satisfactory level, disgust may overrule which could lead to avoidance. The physiological changes that facilitate sexual penetration might also be suppressed leading to more friction and pain with (attempts of) penetration. Whether or not this mechanism is true for women with vaginismus remains to be confirmed.

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# Acknowledgements

That is it, the destination of my PhD-journey in Groningen. This is the part that gives you a hint of the so many people that helped to color and inject encouragement and happiness; which I can say for me, were the core ingredients that kept me going with a smile. Therefore, I apologize beforehand for this lengthy account, but, I will write this and enjoy the ride.

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Its pure fate that I had to work with **Peter** on this project... I googled "sexual disorders, Groningen, fMRI and eating disorders" and Peter was there topping the list! I will never be able to express my gratitude for Peter and his work, it was ping-pong with emails till late at night, weekdays or not. He helped me with exposure and networking, and guided me to a certain level of independence. He always impressed me with his infectious enthusiasm! How he manages to keep up with all the work, being on top of each study main result, sending instant feedback, be so interested in whatever he is involved in (which could be a paper, a design or a BSc thesis), taught me a real lot. Somehow, through thick and thin, he pushed the right buttons to enhance my curiosity and excitement and I can say Peter was a real positive driving force during my studies.

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city, after sunny Malta and the city of London, it took me some energy to decide to stay. But despite the fact I can still speak no proper Dutch, it took me no time to make a group of very special friends, each one special in their own way. I am so thankful for these friendships, built during the time I've been here. I say this with a smile when all the lovely memories slide nicely into my thoughts, what fun we had together, the venting on the hassle of each others project, dealing with rejections, the losing heart of not managing all the high set expectations which happened very often, traveling and living the tourist in my own country, the dinners, the Friday drinks at de Minnaar (and the other days in between), the classic music project at the Oosterpoort, the house painting, the Saturday afternoon's corrections, the vitamin-packed lunch visits etc. Yes, I think of this with a huge grin on my face! I seriously love you. I appreciate also the fact that you all had to speak English because of me, SORRY. You girls (Marieke, Steffie, Elisa, Annika) were for me my Dutch sisters. We spent so much time together, and shared the all. Some things I will always treasure like the birthday call (with my favourite song) from Boston at 00.00, the Sinterklaas evening each year with 100 and 1 gifts, zumba and Steffie's singing my favorite song whilst cycling back home, and my poems that only I understood and thought they rhyme, Johnny's bar, the stay in Den Haag, the arrival of Ede, Annikas' home made cakes and insightful chats... Ladies, we are a lucky bunch! and dearest Karolina, thank you for all the evenings, the catching up chats, and for Poland experience. It was so important for me to talk about all and nothing with you. You are my true confidant.

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Charmaine Borg
October 25, 2013

# Curriculum Vitae and Research Activities

Charmaine Borg was born on the 28th of March 1981, and comes from Malta. She attended Junior College for her higher secondary education and conducted her B.Sc (*hons*) at the University of Malta (UoM). This was a 3-year course carried out in parallel to her full time job at the Acute Short Stay Psychiatric Clinic at St. Luke's hospital, where she worked for 5 years with patients suffering from a large spectrum of psychopathologies (e.g. psychotic episodes, suicide ideations, anxiety and eating disorders). She took this position following a 4-year higher diploma, awarded by the Faculty of Health Sciences, UoM. In 2006, she was a successful candidate for Leonardo da Vinci scholarship and had the opportunity to do an internship in Oxfordshire and Buckinghamshire Mental Health Community Services. She was a casual teacher at the Faculty of Health, UoM, from September 2006 to September 2007. Charmaine then received a scholarship from the Health Department to pursue postgraduate studies. She has earned an M.Sc in Mental Health Sciences from the Institute of Psychiatry, King's College London in January, 2009. The title of her M.Sc thesis was '*Magnetic Resonance Imaging study of the putamen in twins concordant or discordant for schizophrenia*'. Her majors were in Women Health Studies and Cognitive Behavior Therapy. In October 2008, Charmaine was awarded a scholarship from the Ministry of Education of Malta to conduct her PhD studies, she then joined the Faculty of Behavioural & Social Sciences, at the University of Groningen (RuG). She is a member of the *International Academy of Sex Research* (IASR), *the World Association of Sexual Health* (WAS), the *European Society for Sexual Medicine* (ESSM) and the *International Society for Sexual Medicine* (ISSM) and has been invited by several local associations to disseminate her research (e.g., Nederlandse Vereniging Seksuologie, NVVS; Wetenschappelijke Vereniging voor seksuele disfuncties, WVSD). During her PhD studies she was honored with the Experimental Psychopathology Research School (EPP) annual article prize and a presentation prize from the WVSD. Charmaine is continuing on her line of research at the University of Groningen, since January 2013. She balances her life by travelling around the world, fitness, cooking and enjoying wine with her friends.

# Published papers in peer-reviewed journals

1. **Borg, C.,** de Jong, J. P. & Weijmar Schultz, W. (2010) Vaginismus and dyspareunia: Automatic vs. deliberate disgust responsivity. The journal of sexual medicine. 7:2149-2157.

2. de Jong, J. P., van Lankveld, J., Elgersma, H.J., & **Borg, C.** (2010). Disgust and sexual problems: Theoretical conceptualization and case illustrations. International journal of cognitive therapy. 3:24-40.

3. Huijding, J, **Borg, C.,** de Jong, J. P., & Weijmar Schultz, W. (2011). Automatic affective appraisal of sexual penetration stimuli in women with vaginismus or dyspareunia. Journal of sexual medicine. 8: 806-813.

4. **Borg, C.,** de Jong, J. P., & Weijmar Schultz, W. (2011). Vaginismus and dyspareunia: Relationship with general and sex related moral standards. The journal of sexual medicine. 8:223-231.

5. Ettinger, U., Schmechtig, A., Toulopoulou. T., **Borg. C.,** Orrells, C., Owens, S., Marshall, N., Matsumoto, K., van Haren, E. N., Hall, M., Kumari, V., Mc Guire, K. P., Murray, M. R., & Picchioni, M. (2012) Prefrontal and striatal volumes in monozygotic twins concordant and discordant for schizophrenia. Schizophrenia bulletin. 38: 192-203.

6. **Borg, C.,** Peters, L. M., Weijmar Schultz, W., & de Jong, P. J. (2012) Vaginismus: heightened harm avoidance and pain catastrophic cognitions. The journal of sexual medicine. 9:558-567.

7. **Borg, C.,** & de Jong, P. J. (2012) Feelings of disgust and disgust-induced avoidance weaken following induced sexual arousal in women. PLoS ONE. 7(9): e44111.

8. **Borg, C.,** de Jong, P. J., Renken, R. J., & Georgiadis, R. J. (2013) Disgust trait modulates frontal-posterior coupling as a function of disgust domain. Socio cognitive and affective neuroscience (SCAN). 8: 351-358.

9. **Borg, C.,** de Jong, P. J., & Georgiadis, R. J. (2013) Subcortical BOLD responses during visual sexual stimulation vary as a function of implicit porn associations in women. Socio cognitive and affective neuroscience (SCAN). doi: 10.1093/scan/nss117.

10. de Jong, P. J., van Overveld, M., & **Borg, C.** (2013) Review: Giving in to arousal, or staying stuck in disgust? Disgust-based mechanisms in the development of sexual dysfunctions. The journal of sex research, special edition - Annual review of sex research. 50: 247-462.

11. Spoelstra, K., **Borg, C.,** & Weijmar Schultz., W. (2013) Anticonvulsant pharmacotherapy for generalized and localized vulvodynia: a critical review of the literature. Journal of psychosomatic obstetrics & gynecology. 34: 133-138

# Book chapter

1. de Jong, P. J., & **Borg, C.** (2013) Sexual disgust and sexual behaviour. To appear in: Powell, P.A., Overton, P.G., & Simpson, J. (eds). The revolting self: perspectives on the psychological and clinical implications of the self-directed disgust

# Articles under peer-review

1. **Borg, C.,** Georgiadis, R. J., Renken, R. J., Spoelstra, K., Weijmar Schultz, W., & de Jong, P. J. (2013) Brain processing of sexual penetration versus core and animal-reminder disgust pictures in women with genito-pelvic pain/penetration disorders. [submitted]

2. Molaeinezhad, M., Merghati, K. E., Mehrdad, S., **Borg, C.,** Latifnejad Roudsari, R., Yousefy, A., Shafiei, K., & Salehi, P. (2013) Marriage consummated for 32 Iranian women using therapist-aided exposure therapy: A brief report. [submitted].

3. Spoelstra, K., **Borg, C.,** Reissing, E., & Weijmar Schultz., W. (2013) The pain, the brain and the pelvic floor: vaginal reflexes and Genito-Pelvic Pain/Penetration Disorder.[submitted].

# Published papers in national journals

1. **Borg, C.,** & de Jong, P. J. (2009) Disgust and vaginismus. Blind-interdisciplinair tijdschrift ziedaar (on-line Journal Ziedaar).

2. Hanema, Y., de Jong, P. J., **Borg, C.,** & Weijmar Schultz, W.C.M. (2012) Seksuele functiestoornissen: de mogelijke rol van negatieve emotionele reacties, Nederlands tijdschrift voor obstetrie & gynaecologie vol. 129, juni 2012.

3. Bosman, R., **Borg, C.,** de Jong, P. J., & Georgiadis, R. J. (2013) Kijken naar porno: subcorticale hersenactiviteit weerspiegelt de negatieve maar niet de positieve impliciete associaties met expliciete pornografie. Neuropraxis, Invited contribution.

4. de Jong, P. J., **Borg, C.,** & Elgersma, H. (2013) Seksuele aversie en de DSM-5: verwijderd als stoornis maar als symptoom overminderd relevant, Nederlands tijdschrift voor seksuologie, Invited contribution.

# Media coverage

Our research: (`http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0044111`) has been covered by the Scientific American, TIME magazine, U.S. News & World Report, The Huffington Post and ABC News. Media coverage extended to UK - The Times of England, Daily news; the metro, the guardian, as well as media in Ireland, India, Malaysia, Germany, Sweden, the Netherlands, Austria, Malta, Australia, Italy, and Brazil among others.

Appeareance in a national TV programme covering Disgust and Sex (8e seizoen): `http://www.wetenschap24.nl/programmas/labyrint.html` Aired by VPRO on October 13th, 2013. On Nederland 2, at 19.50.

# Awards and scholarships

- March 2006, Leonardo da Vinci Project, Internship in Psychiatric & Mental Health Services in Oxfordshire.

- July 2007, Malta Government, Health Department for an international MSc in Mental Health Studies, 52,000Euros.

- August 2008, Malta Government Scholarship Scheme, Education Department for PhD studies MGSS. Grant number MGSS PHD 2008-12, 30,000Euros.

- October 2008, Bursaal position at the University of Groningen.

- January 2011, Prize for an oral presentation at the Wetenschappelijke Vereniging voor seksuele disfuncties, 500Euros.

- April 2011, Experimental Psychopathology Article Award Academic Year 2009/2010, 450Euros.

- July 2012, Scholarship for post-doc fellowship with CRIPCAS, an interdisciplinary research centre on intimate relationship problems and sexual abuse at the University of Montreal, under the main supervision of Dr Sophie Bergeron and Professor dr Mireille Cyr.

# Conferences and symposiums

- Borg, C., Vaginismus: Automatic vs. deliberate disgust and threat related associations. The 43rd American Cognitive Behaviour Therapy Convention (ABCT), 19-22nd November, 2010. New York, US. [Poster Presentation].

- Borg, C., Vaginismus: Physiological disgust responsivity using EMG. The World Congress of Behaviour Cognitive Therapy (WCBCT), 2011. 2-5th June, Boston, USA. [Poster Presentation].

- Borg, C., Female sexual pain disorders. Poster Presentation at the Research School Experimental Psychopathology (EPP), 2010. Utrecht, Netherlands. [Poster Presentation].

- Borg, C., A Journey into the relams of disgust in sexual dysfunction: Female sexual pain disorders. Nederlandse Vereniging Seksuologie (Dutch Sexology Association Meeting). 26th March, 2010. Utrecth, Netherlands. [Oral Presentation].

- Borg, C., Developments in the aetiology and treatment of primary Vaginismus. The 16th International Congress of the International Society of Psychosomatic Obstetrics and Gynecology. 28-30th October 2010. Venice, Italy. [Symposium].

- Borg, C., The emotion of disgust against the expressed wish to make love: Vaginismus. The Gyneacologists and Urologists Annual Evening Meeting (de regioavond Urologie/Gynaecologie). 13th December, 2010. Groningen, Netherlands. [Oral Presentation].

- Borg, C., The high conservative-low liberal standards and restrictions in sexual behaviour: Vaginismus. The year congress of WVSD (Wetenschappelijke Vereniging voor seksuele disfuncties). 7th January, 2011. Ede, Netherlands. [Oral Presentation]. *Prize for the presentation* (vrije voordrachten)

- Borg, C., Disgust interwoven with Female Sexual Pain Disorders. Research colloquium. 14th January, 2011. Emotional Brain Institute, Almere, Netherlands. [Oral Presentation].

- Borg, C., Experimental Psychopathology (EPP) ***Article Award Presentation, Academic Year 2009/2010. 1st April 2011, Utrecht, Netherlands. [Oral Presentation]**.

- Borg, C., Disgust beyond Filth . Research colloquium. 4th April, 2011. Medical Faculty Functional Anatomy dept., Groningen, Netherlands. [Oral Presentation].

- Borg, C., Personality traits of harm avoidance and pain catastrophic cognitions in females with vaginismus but not in dyspareunia; Symposium on pain and suffering. 13th May, 2011, Leuven, Belgium. [Poster Presentation].

- Borg, C., Personality traits of harm avoidance and pain catastrophic cognitions in females with vaginismus. Research Colloquium at Maastricht University. 27th May, 2011. Maastricht, Netherlands. [Oral presentation].

- Borg, C., High morality in vaginismus. World Association for Sexual Health (WAS), 12th-16th June, 2011. Glasgow, Scotland. [Oral Presentation]. Abstract published in Journal of sexual medicine. 8:119. [Podium Session].

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